Appendix C – Site Analysis for the Chevron Refinery Community Air Monitoring Station

Executive Summary

This Appendix describes the factors and analyses used to identify a geographic area for siting a community air quality monitoring station near the Richmond Chevron Refinery as part of the Major Stationary Source Community Air Monitoring Program (Schedule X).[1] The goal in siting monitors under Schedule X is to select a location that will reflect typical conditions in impacted areas of the community based on a broad range of factors and the weight of available evidence associated with those factors. Importantly, no single fixed monitoring location will capture all the emissions from a given facility.

Air District staff considered several factors for this evaluation, including emissions sources, available meteorological and air quality data, area geography and topographical features, results from health risk assessments and air quality modeling, environmental justice indicators, and stakeholder input. After considering these factors, two potential options for additional air monitoring include:

1. Enhancing monitoring at the Air District's existing San Pablo-Rumrill monitoring station, given relatively higher concentrations of $PM_{2.5}$ and certain air toxics measured there historically, as well as the fact that this station already includes monitoring for several pollutants. Furthermore, installing additional air monitoring equipment at an existing station is typically faster than establishing a new air monitoring station. While the Air District's existing Richmond-7th St. monitoring station is also nearby and is closer to the refinery than the San Pablo monitoring station, it measures only SO_2 and air toxics, and the historical concentration data have been relatively low. Therefore, enhancing monitoring at the San Pablo monitoring station is a preferred option to enhancing monitoring at the Richmond-7th St. monitoring station.

2. Establishing a new air monitoring station, likely in Richmond and nearer to the Chevron Refinery than the Air District's San Pablo monitoring station. In this case, multiple locations may be acceptable candidates for enhanced air monitoring, as highlighted in the recommended search area in Figure C-1. Census tracts overlapping with North Richmond and the Iron Triangle, Atchison Village, Coronado, and Santa Fe neighborhoods in Richmond have generally higher scores as overburdened communities (CalEnviroScreen composite scores over 90%) compared to the location of the Air District's San Pablo monitoring station. In addition, the ZIP code that includes North Richmond and several Richmond neighborhoods immediately adjacent to the Chevron Refinery (94801) had the highest number air quality complaints received by the Air District compared to other ZIP codes in the Richmond area. These locations are also in closer proximity to the Chevron Refinery compared to the Air District's existing multipollutant monitoring station in San Pablo.

Recommendation: While either option may be suitable, establishing a new air monitoring station can take a considerable amount of time as it necessitates identifying new candidate site locations, assessing those locations for logistical, siting, and other monitoring requirements, and installing and testing monitoring equipment. Therefore, it is recommended to proceed with enhancing monitoring at the existing San Pablo-Rumrill monitoring station, and when monitoring resources allow, subsequent monitoring at a new location within the recommended search area should be considered.

[1] Overview of the Major Stationary Source Community Air Monitoring Program: https://www.baaqmd.gov/~/media/files/technical-services/community-air-monitoring/01_refinery-camp-v7-mainapp-a-pdf.pdf

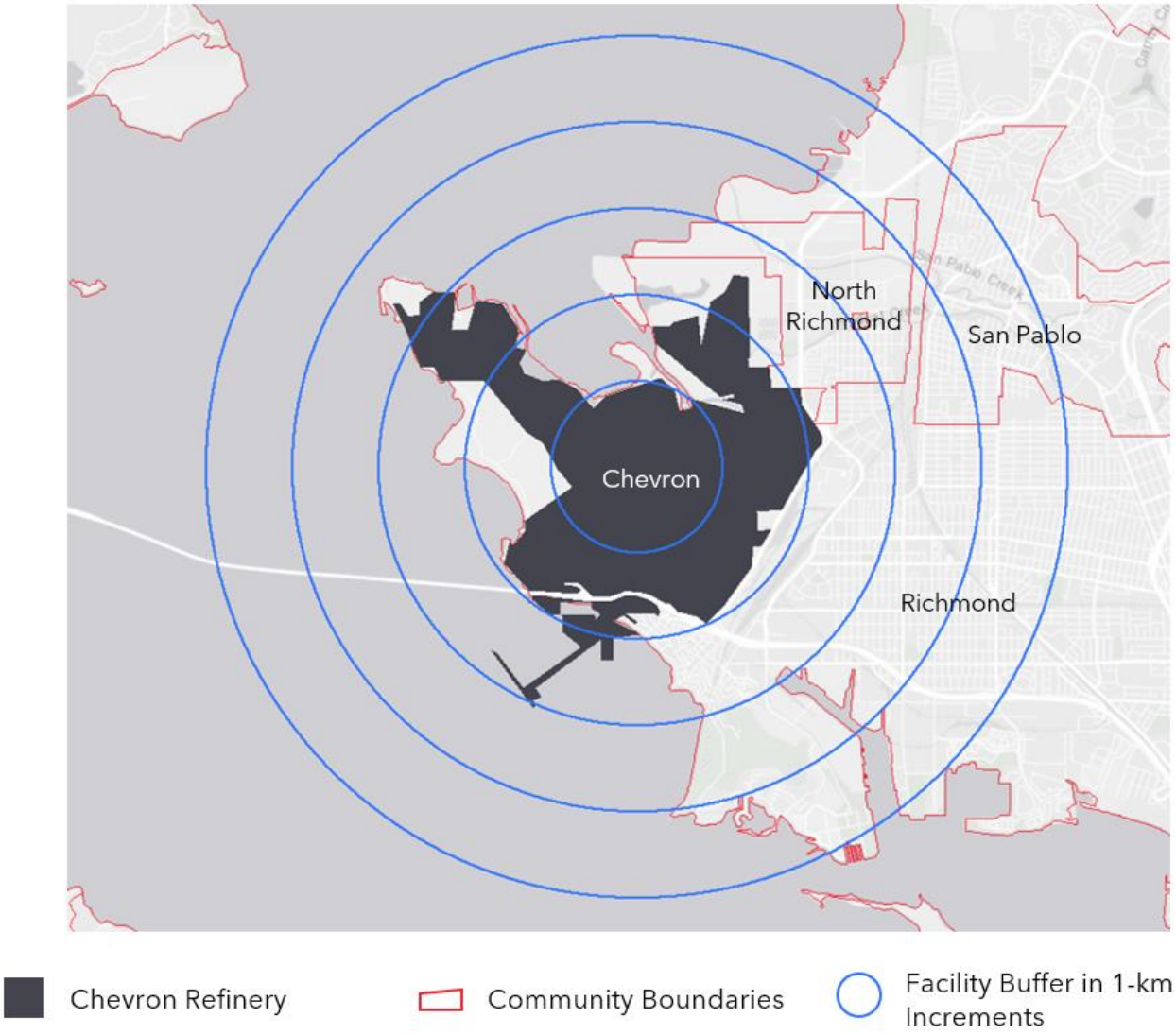
Figure C-1 – Recommended Search Area for the Chevron Refinery Major Stationary Source Community Air Monitoring Station, When Resources Allow Following Enhancing Monitoring at the Existing San Pablo-Rumrill Air Monitoring Station

Study Area for Siting Analysis

A neighborhood-scale monitoring station located within a few kilometers of the Chevron Refinery is most appropriate given the objectives of the Major Stationary Source Community Air Monitoring Program.

In Figure C-2 below, the Chevron Refinery is shown in gray with concentric buffers around the facility in 1 km increments. Portions of the buffers intersect the communities of Richmond, North Richmond, and San Pablo. Many residents in this area experience disproportionate cumulative health impacts and the area includes a high density of complex pollution sources in and near residential neighborhoods.

Figure C-2 – Location of the Chevron Refinery



Population Centers

With an estimated population of 109,884 (US Census Bureau, 2020), the City of Richmond is in western Contra Costa County on a peninsula separating the San Francisco Bay on the south and the San Pablo Bay on the north. The shoreline defines Richmond's borders to the north, west, and south; the cities of El Cerrito, San Pablo, and Pinole and the unincorporated areas Contra Costa County border the north and east; and the Berkeley Hills, San Pablo, and Sobrante ridges border the east. A zoning map (Figure C-3) from the City of Richmond (2022) shows that the city is largely residential and industrial, which includes the 2,900-acre Chevron Refinery on the west side of the city. The unincorporated community of North Richmond is located north of Richmond and west of San Pablo and has an estimated population of 4,085 (US Census Bureau, 2020). The Chevron Refinery is also located about one and a half miles west of central San Pablo. The City of San Pablo has an estimated population of 30,967 (US Census Bureau, 2020) and is bounded by Richmond on the north, west, and south and by the unincorporated community of El Sobrante on the east. A zoning map (Figure C-4) from the City of San Pablo (2018) shows that the city is primarily residential.

Figure C-3 – City of Richmond Zoning Map

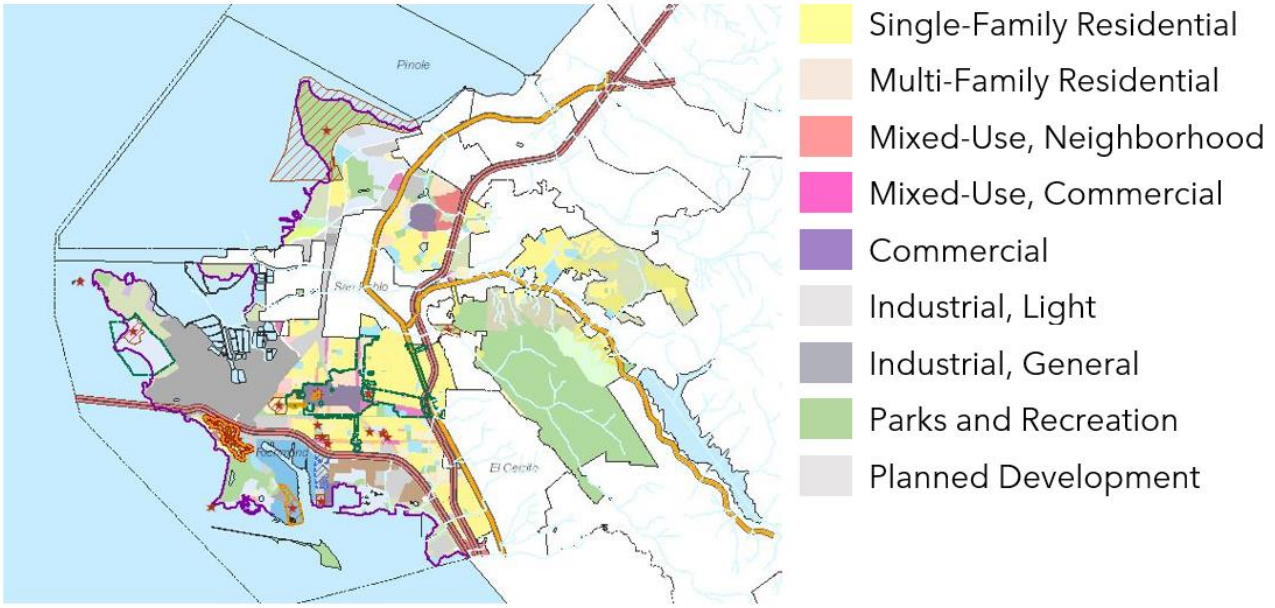
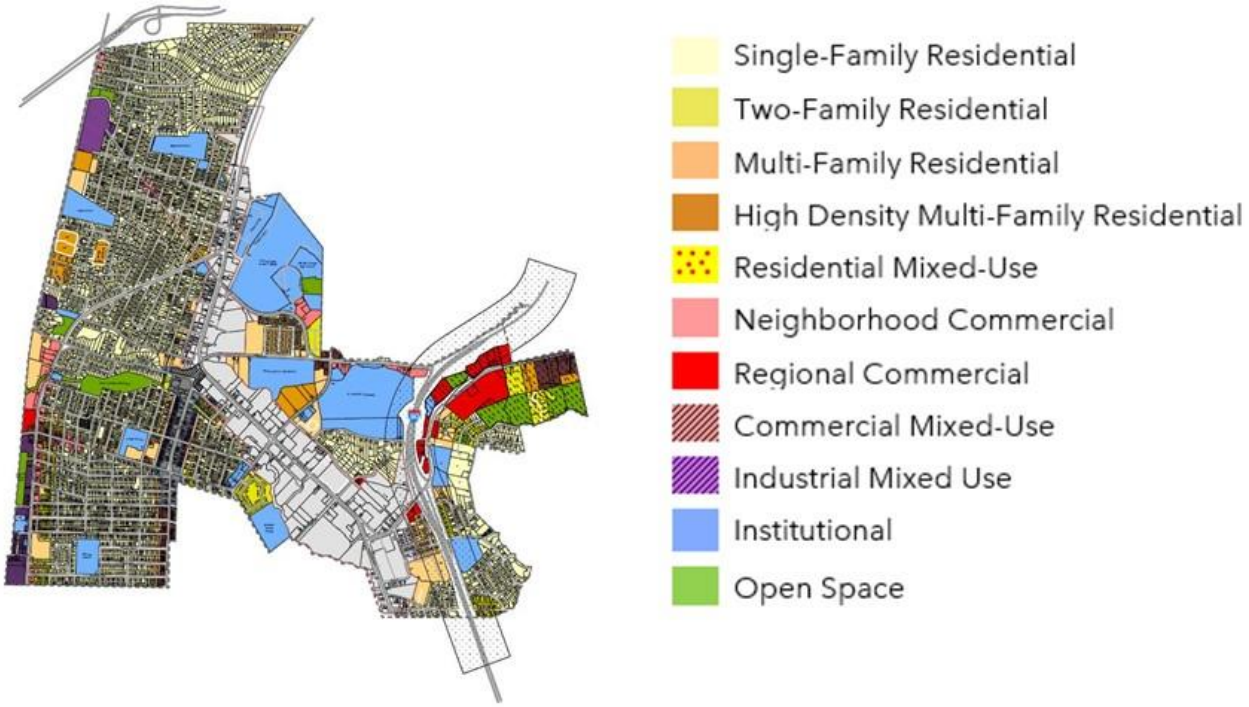


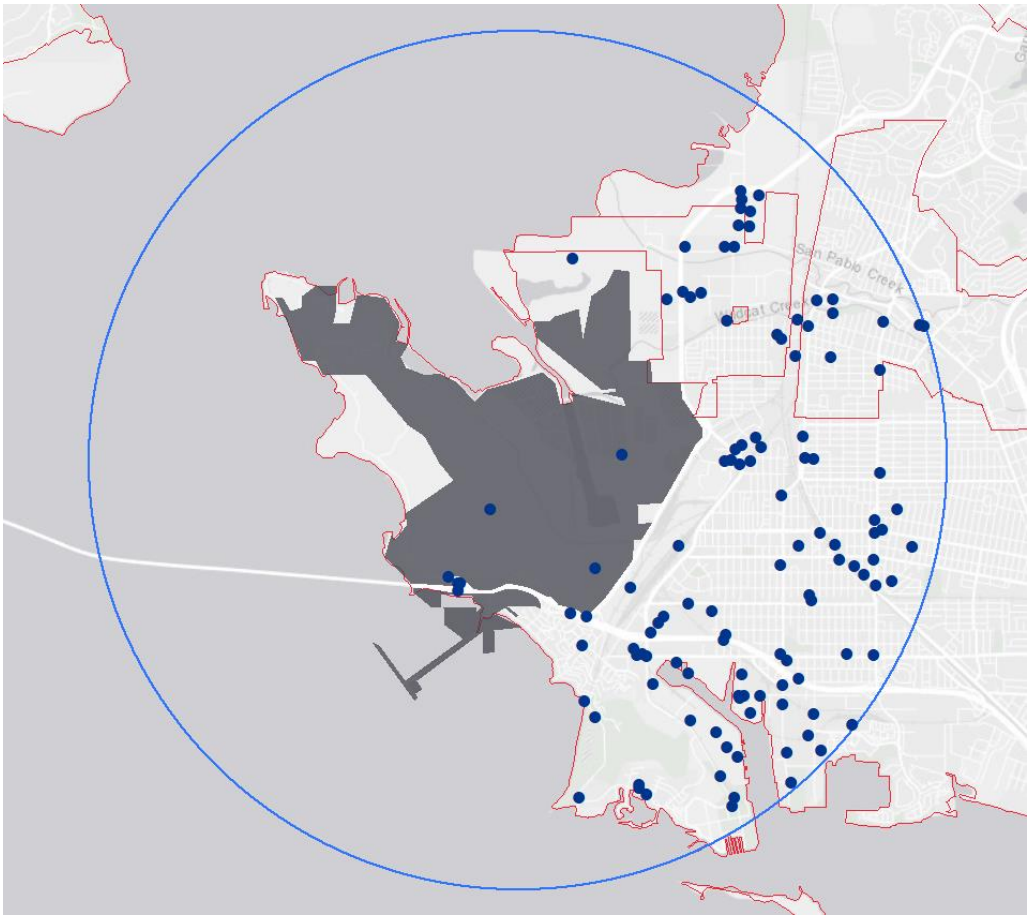
Figure C-4 – City of San Pablo Zoning Map



Local Emissions Sources

According to the Air District's database of regulated facilities, there are 118 permitted sources within a 5 km radius of the Chevron Refinery (Figure C-5).

Figure C-5 – Locations of Permitted Facilities Near the Chevron Refinery



The Chevron Refinery is the largest stationary source of air pollution in the area. To highlight some of the other relatively sizeable stationary sources of air pollution in the area, stationary sources with more than 20 tons per year of emissions of a single pollutant are shown in Figure C-5, and their emissions are summarized in Table C-1. The West Contra Costa County Landfill, Chevron Products Company, Chemtrade West US LLC, and Levin Richmond Terminal Corporation have paid major stationary source community air monitoring fees under Regulation 3, Schedule X.

In addition, numerous smaller commercial sources of air pollution are located throughout the area, including auto body shops, paint shops, gas stations, and restaurants. The area also includes high-volume roadways such as I-80, I-580, Richmond Parkway, and other busy roadways that cut through residential neighborhoods, as well as truck operations associated with large distribution centers and industrial facilities. Additional sources of air pollution include marine and seaport operations, railways and railyards, and numerous construction sites.

Figure C-6 –Stationary Sources Near the Chevron Refinery Emitting More Than 20 Tons per Year of a Single Pollutant

1 – West Contra Costa County Landfill(1)
2 – Chevron Products Company(1)
3 – Chemtrade West US LLC(1)
4 – Levin Richmond Terminal Corporation(1)
5 – Phillips 66 Company

Notes: (1) The West Contra Costa County Landfill, Chevron Products Company, Chemtrade West US LLC, and Levin Richmond Terminal Corporation pay fees for Major Stationary Source Community Air Monitoring under Regulation 3, Schedule X

Table C-1 – Annual Emissions from Stationary Sources Near Chevron Emitting More Than 20 Tons per Year of a Single Pollutant(1)

Facility (CEIDARS ID)	Annual Emissions (tons/year)					
	CO	NOx	PM_{10}	$PM_{2.5}$	ROG	SOx
Chevron (10)	408.9	747.6	310.9	302.4	517.2	417.7
Chemtrade West US LLC (23)	4.5	1.9	5.3	5.3	0.3	169.7
Levin Richmond Terminal Corporation (935)	0.5	1.5	17	10.2	0.1	0
Phillips 66 Company (21227)	0	0	0.1	0.1	123.4	0
West Contra Costa County Landfill (1840)	48.4	11.6	16.4	14.4	96.1	2.1

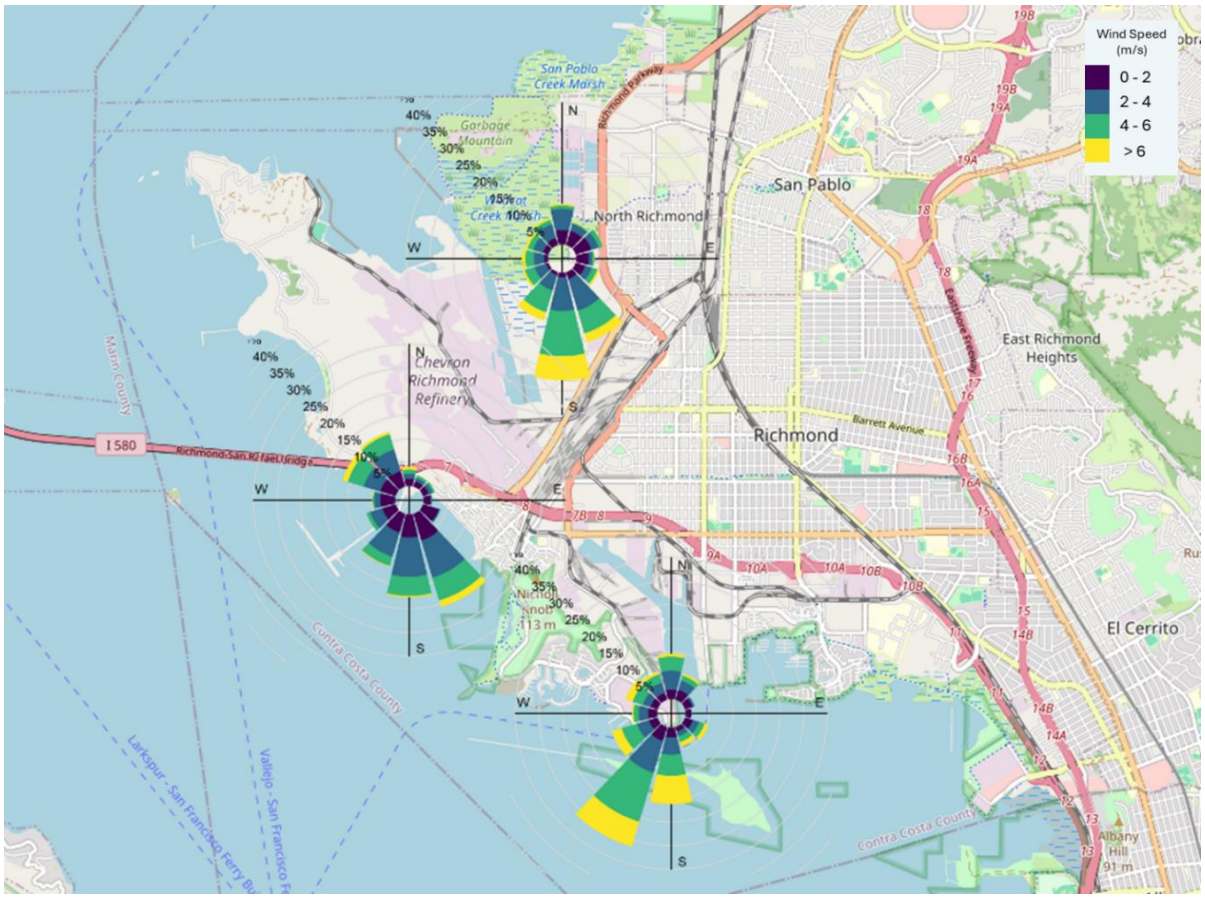
Notes: (1) Criteria pollutant emissions are for the 2021 reporting year, obtained from the California Emissions Inventory Data Analysis and Reporting System (CEIDARS).

Wind Climatology and Topography

The movement of air and topography (such as hills or valleys) significantly affect where emitted air pollutants end up and get concentrated. Therefore, when identifying potential locations for an air monitoring station to capture the effects of these emissions on ambient concentrations, it is necessary to consider historical wind patterns and topographical features in the area. In this case, the Air District performed a multi-year (2018-2022) analysis of wind data from selected meteorological stations around the Chevron Refinery, including the Chevron-Gertrude Ground Level Monitor (GLM) and two National Oceanic and Atmospheric Administration (NOAA)-affiliated meteorological stations.[2]

Typical year-round wind patterns are summarized by the wind roses in Figure C-7. A wind rose shows the general wind direction and speed for a particular sampling period. The circular structure of the wind rose shows the direction the winds blew from, and the length of each "spoke" around the circle shows how often the wind blew from that direction. The different colors of each spoke provide details on the wind speed. Wind data from all three stations illustrate that winds are common from multiple directions though are most prevalent from the south, southeast, or southwest (in general, from the direction of San Francisco Bay). Importantly, at any time of year, winds can vary considerably within an area over the course of a day.

Figure C-7 – Wind Roses for Nearby Meteorological Stations (2018-2022)



[2] Data from NOAA-affiliated meteorological stations were obtained through MesoWest: https://mesowest.utah.edu/

Winds also vary considerably by season and time of day, as shown in the wind rose plots in Figures C-8 through C-13. With its proximity to the San Francisco Bay, there are two general wind patterns in this area: onshore winds and offshore winds. The late spring, summer, and early fall seasons are characterized by onshore winds (winds from the south or off San Francisco Bay) that are strongest during the afternoon hours. In late fall, winter, and early spring, winds typically switch periodically from onshore to offshore (from the north) as storm systems move through the Bay Area. Winds from the south or southeast would tend to transport refinery-related emissions away from residential areas, while winds from the southwest, west, or northwest may transport emissions into residential areas of Richmond, North Richmond, and San Pablo. During offshore wind patterns, northerly winds may transport refinery-related emissions into Point Richmond. Light winds (under 2 m/s) are also common, particularly overnight. Calm or light winds from variable directions can limit dispersion and allow pollutants to build-up in the local area.

Figure C-8 – Wind Roses for Winter (Dec-Jan-Feb 2018-2022)

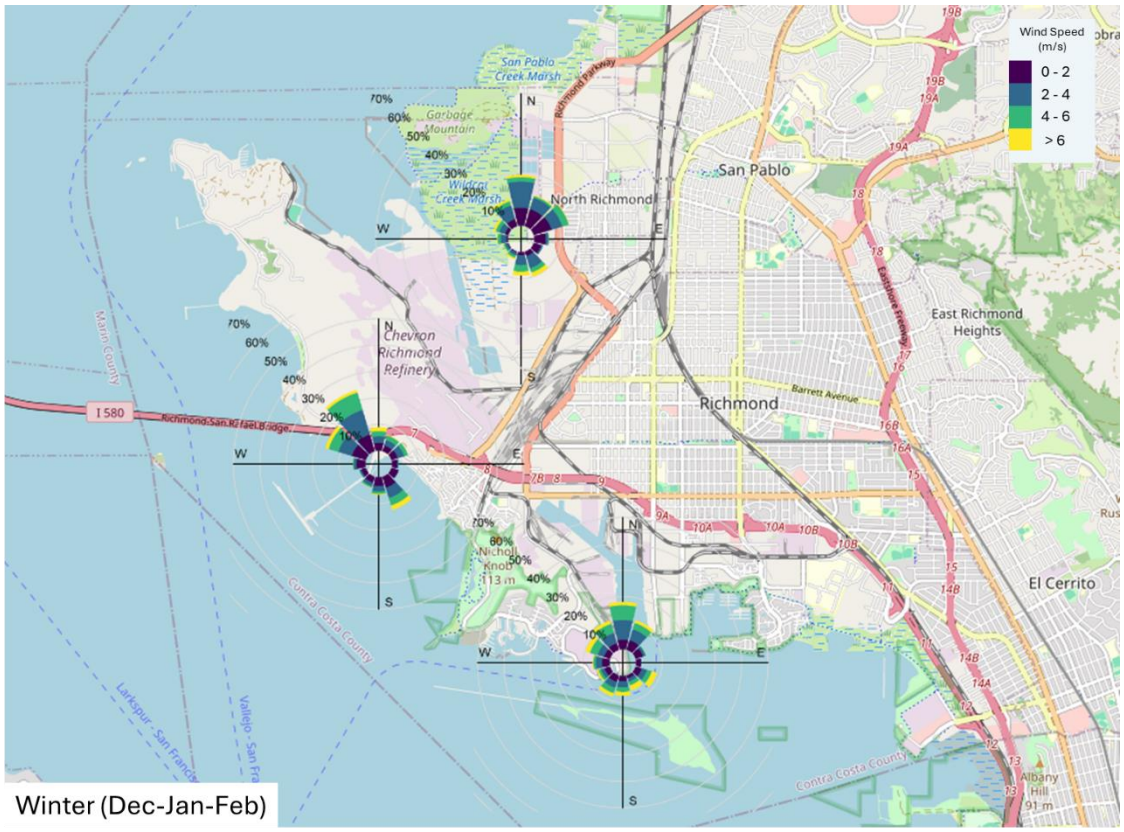
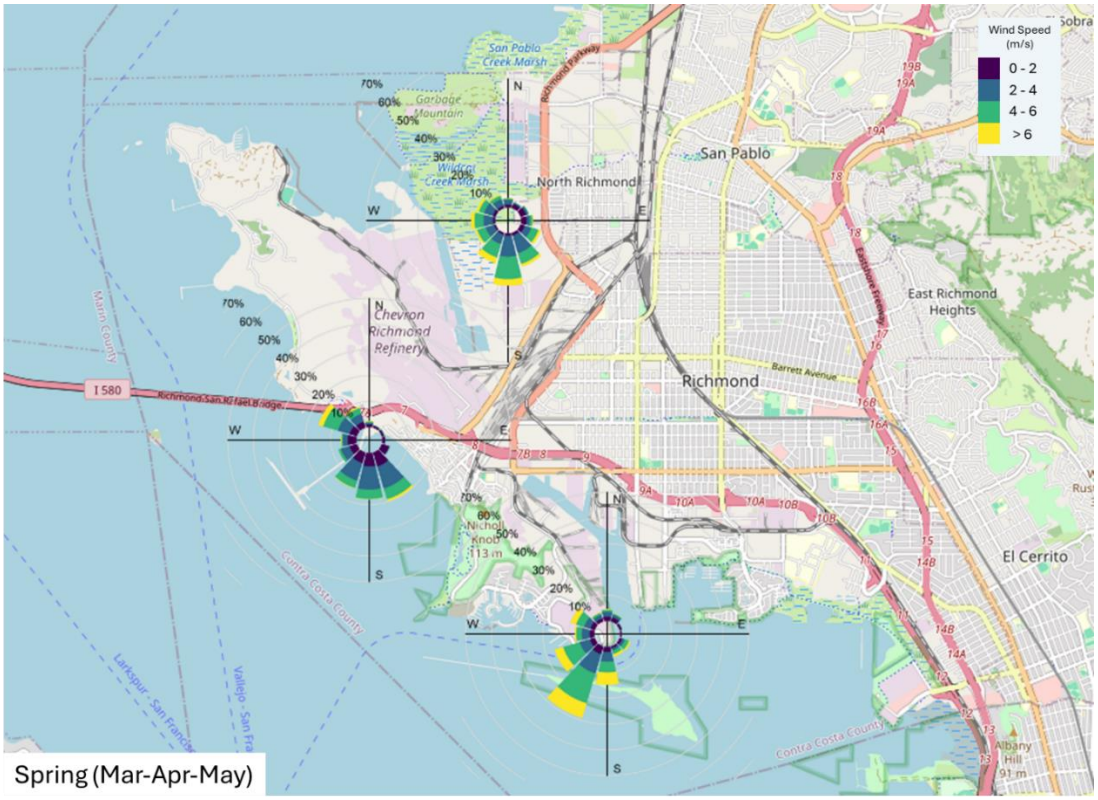
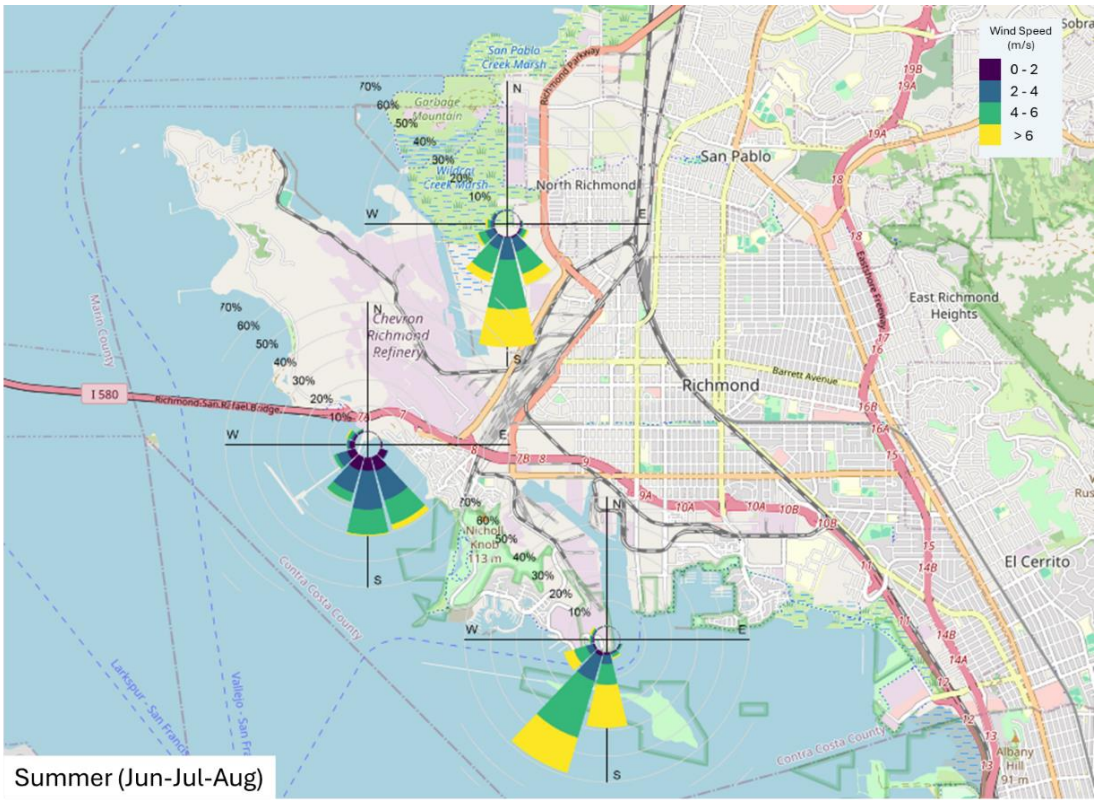


Figure C-9 – Wind Roses for Spring (Mar-Apr-May 2018-2022)



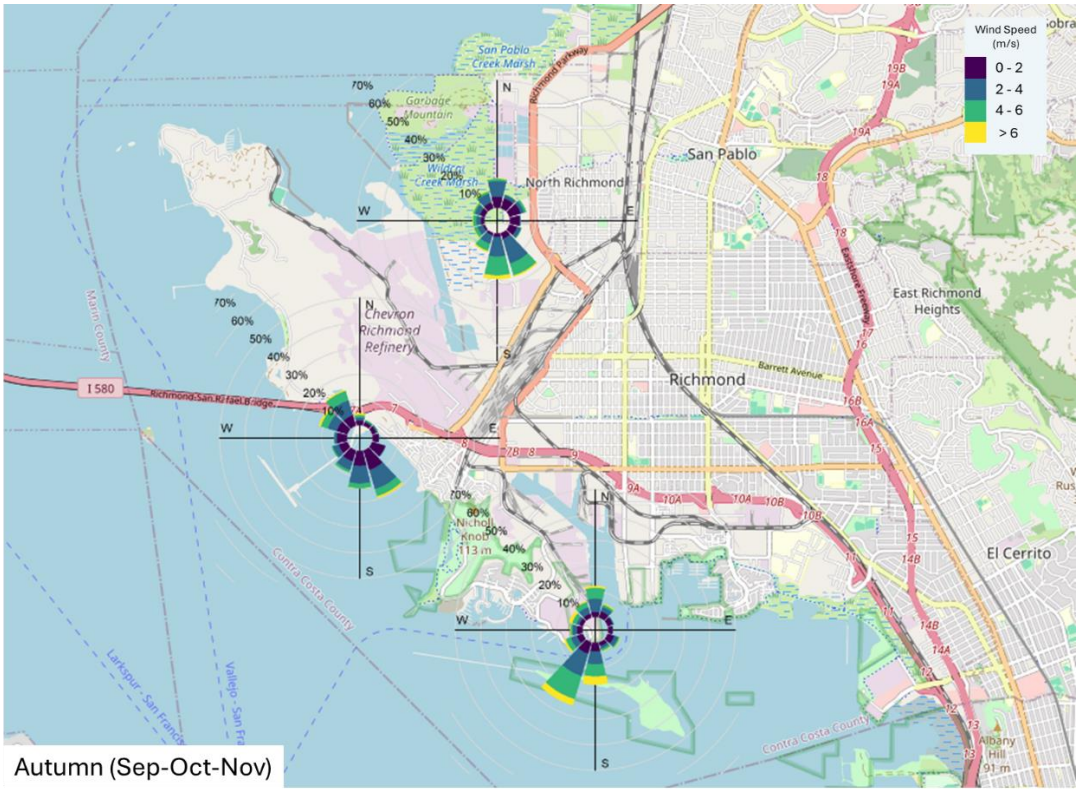
Spring (Mar-Apr-May)

Figure C-10 – Wind Roses for Summer (Jun-Jul-Aug 2018-2022)



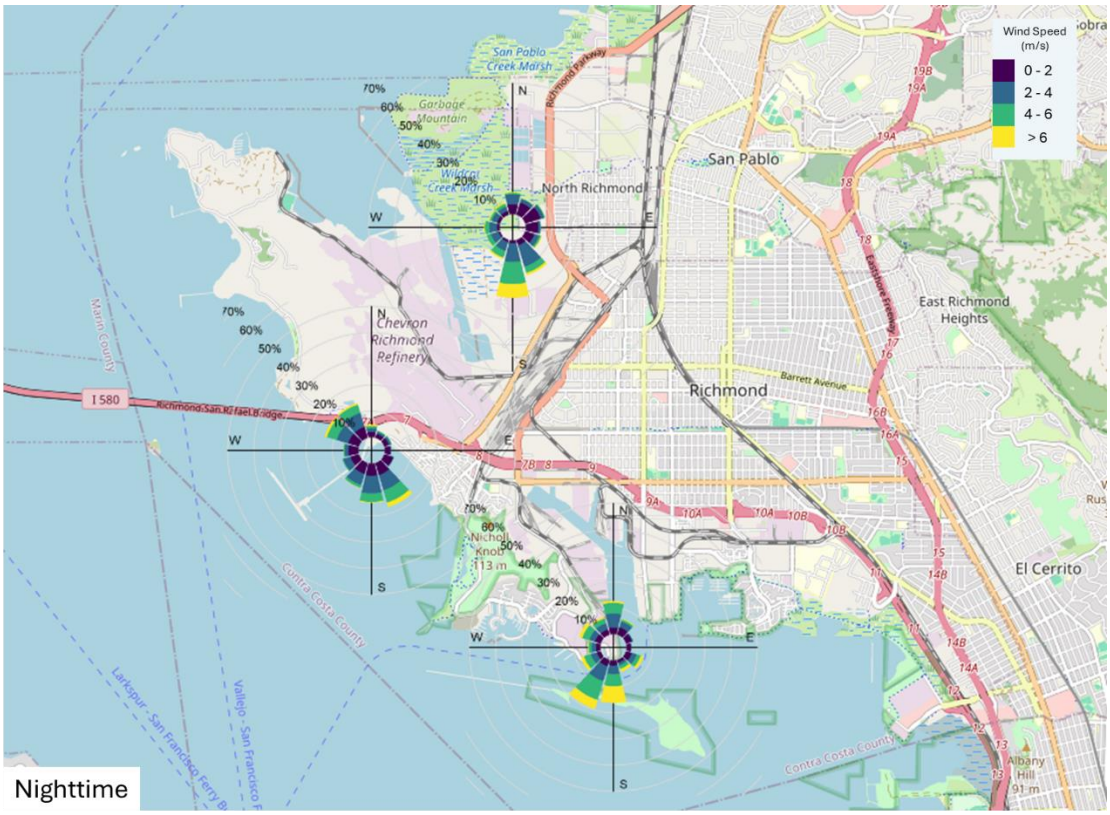
Summer (Jun-Jul-Aug)

Figure C-11 – Wind Roses for Autumn (Sep-Oct-Nov 2018-2022)



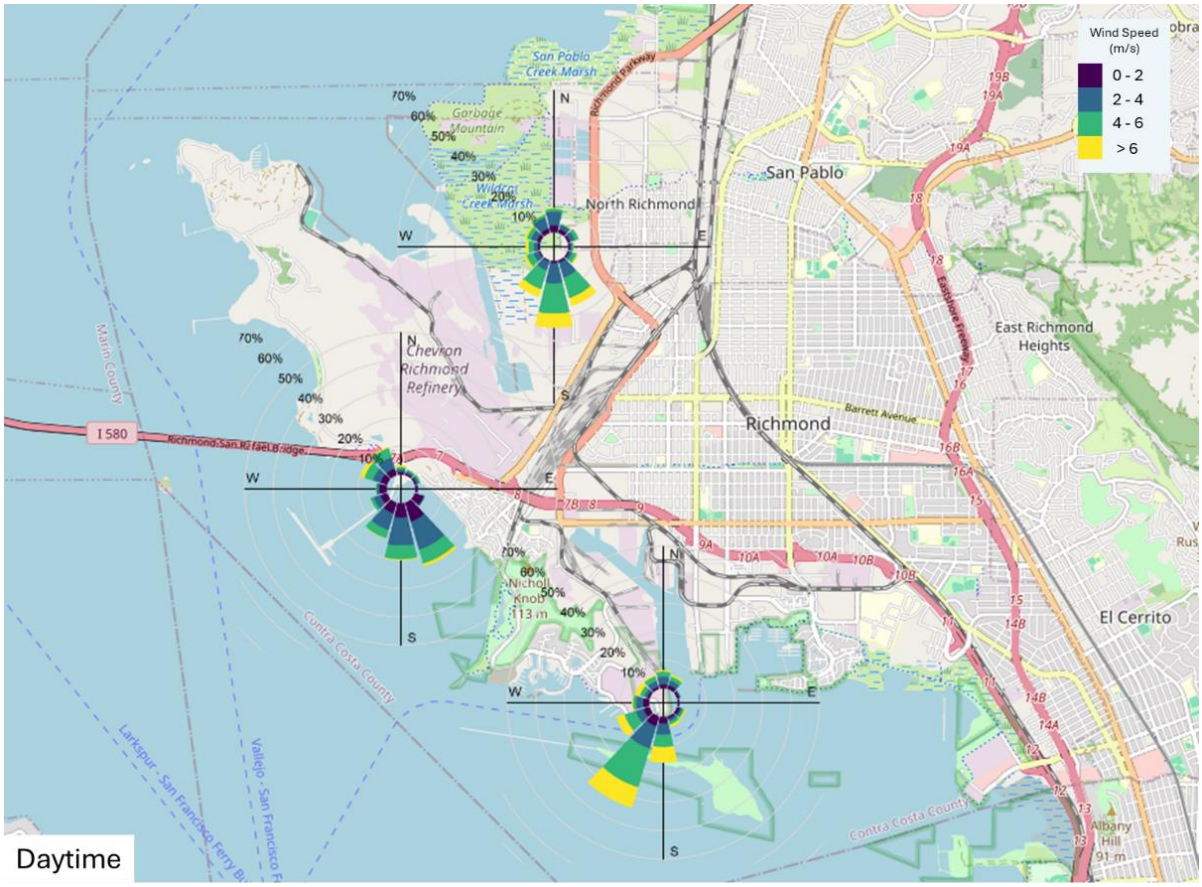
Autumn (Sep-Oct-Nov)

Figure C-12 – Wind Roses for Nighttime (2018-2022)



Nighttime

Figure C-13 – Wind Roses for Daytime (2018-2022)



While some wind patterns are driven by global or regional phenomena, topography can drive additional circulation at the local level, which may impact the dispersion and transport of pollution; the nature and degree of this impact depends on the specific arrangement of physical features in the area.

The shaded relief maps in Figure C-14, Figure C-15, and Figure C-16 show the terrain surrounding the Chevron refinery. A prominent topographic feature adjacent to the facility is a ridge of coastal hills along the Point San Pablo peninsula that extends into the Point Richmond neighborhood, with a peak elevation of around 470 feet (Figure C-16). However, the majority of the area surrounding the refinery is low-lying and relatively flat.

When considered together, the prevailing wind patterns and topographic features would generally suggest the community air monitoring station should be placed north of the refinery. However, most of the area directly north of the facility is unpopulated land or waters of the San Pablo Bay. When also considering local land uses described previously, the best placement of community air monitoring stations would generally be to the east or northeast of the refinery.

Figure C-14 – Topography Around the Chevron Refinery

Figure C-15 – Topography Around the Chevron Refinery

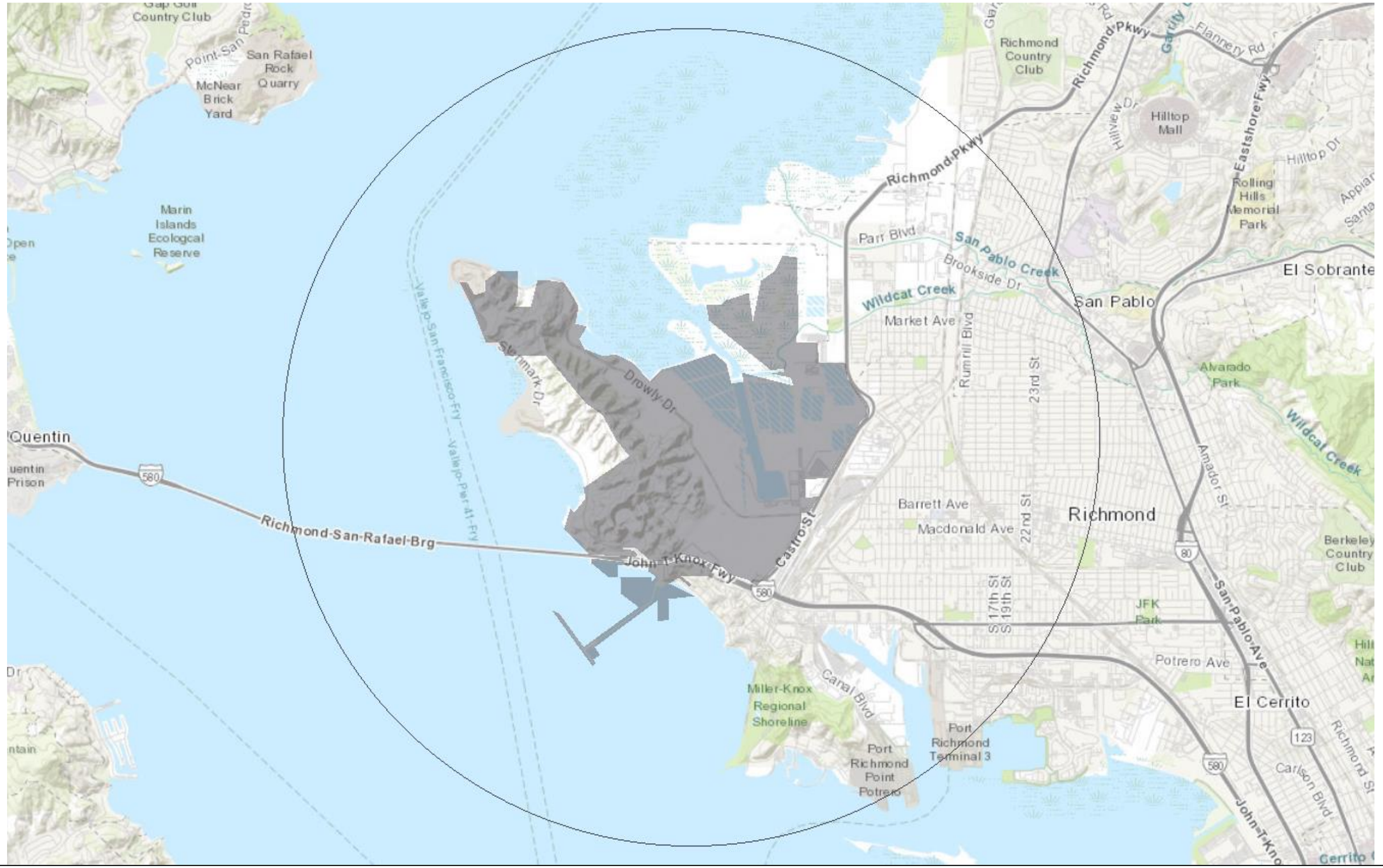
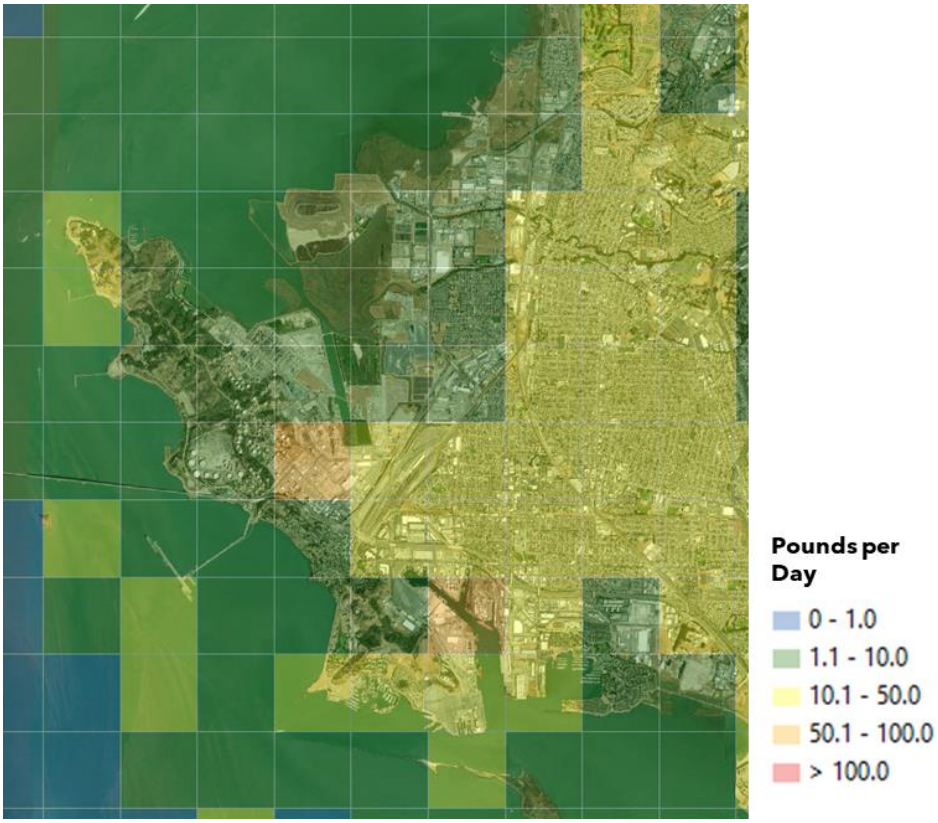


Figure C-16 – Topography Around the Chevron Refinery

Health Risk Data, Sensitive Populations, and Environmental Justice Considerations

In an analysis for the Air District's Community Air Risk Evaluation (CARE)[3] project, estimated emissions of certain toxic air contaminants (TACs) from permitted stationary sources, on-road mobile sources, and distributed area sources in 2015 were allocated to a grid of cells with a spatial resolution of 1-km for use in cancer-risk modeling. This modeling effort found that five compounds (diesel PM, acetaldehyde, benzene, 1,3-butadiene, and formaldehyde) were responsible for more than 90% of the cancer risk attributed to emissions. The estimated combined TAC emissions of these compounds for the Richmond-San Pablo area are shown in Figure C-17. The greatest estimated emissions of TACs in the area are associated with the Chevron refinery.

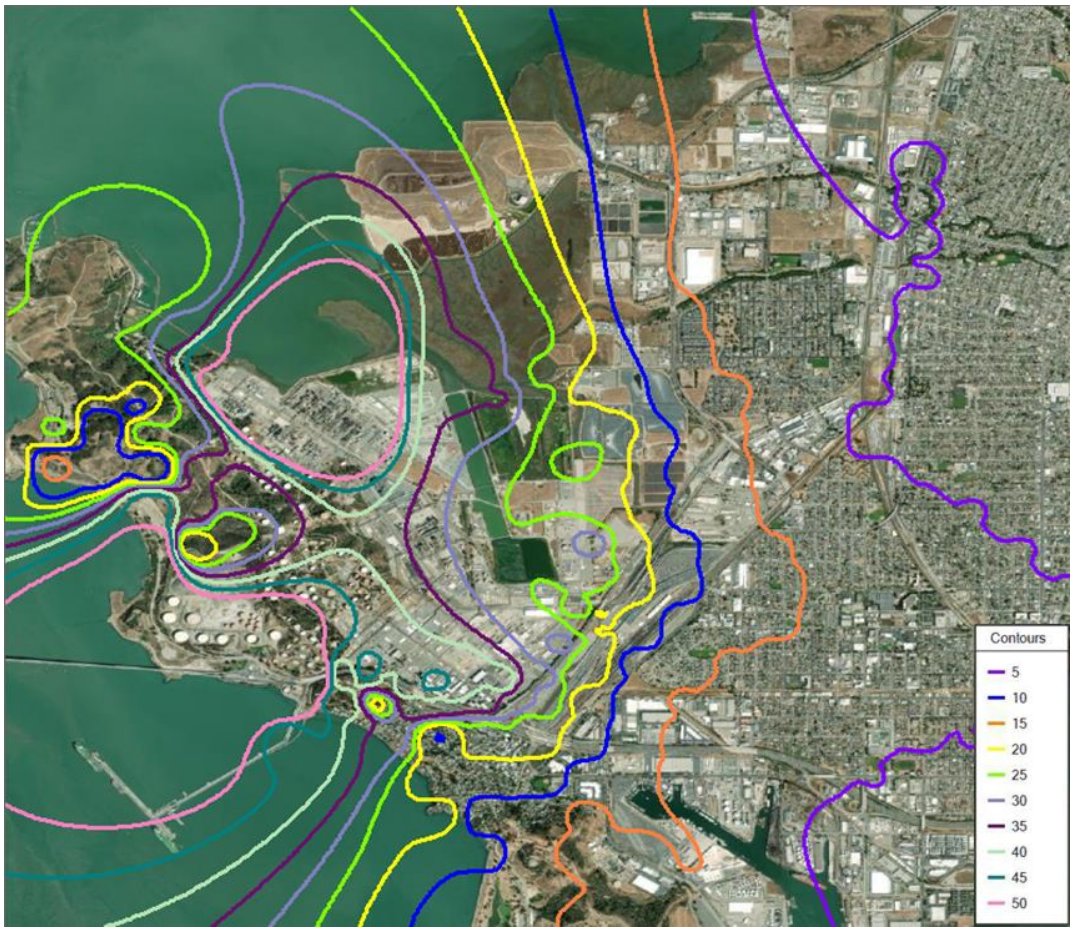
Figure C-17 – Estimated Emissions of Selected TACs in the Richmond-San Pablo Area (2015)



In a separate analysis, the Air District estimated health impacts from air contaminants by reviewing a Health Risk Screening Assessment (HRSA) from 2015 for the Richmond-San Pablo area using toxic emissions inventories provided by Bay Area refineries and meteorological data generated through AERMOD, to illustrate the locations of expected maximum impacts for a range of conditions and magnitude of those impacts. The Air District will be conducting a new air toxics evaluation for Chevron under Rule 11-18, but that work is not expected to impact the general results of this analysis for the community air monitoring station. Figure C-18 shows the estimated cancer risk (in one million) for the area due to emissions from the Chevron Refinery. The areas with the greatest estimated elevated cancer risk (> 50 in a million) include the refinery itself and waters around the refinery and its loading berth. The cancer risk decreases with distance from the refinery with the contours generally exhibiting a pattern extending north-northeast from sources at the refinery.

[3] Website for the Air District's CARE Program: https://www.baaqmd.gov/community-health/community-health-protection-program/community-air-risk-evaluation-care-program

Figure C-18 – Contours of Estimated Cancer Risk (in one million) from a 2015 Health Risk Assessment of Emissions from the Chevron Refinery.



When considering the health impacts from air pollution, it is also instructive to consider biological traits, health status, or other community characteristics that can result in increased vulnerability to pollution. A number of these population characteristics have been incorporated into the CalEnviroScreen (CES)[4] model (version 4.0), which identifies California communities by census tract that are disproportionately burdened by, and vulnerable to, multiple sources of pollution. CalEnviroScreen uses 21 statewide indicators to characterize pollution burden and population characteristics. Individual indicator scores are provided along with composite scores based on a specified formula. The population characteristics used by CalEnviroScreen are: emergency department visits associated with asthma, cardiovascular disease (emergency department visits for heart attacks), low birth-weight infants, educational attainment, housing-burdened low-income households, linguistic isolation, poverty, and unemployment. The percentiles for the 17 census tracts that intersect the 5 km buffer around Chevron are summarized below in Figure C-19 and Table C-2.

Overall, tract 2 (North Richmond) and tract 11 (Iron Triangle), 14 (Atchison Village), and 16 (Santa Fe and Coronado) have the highest composite CES scores, falling above the 90th percentile. All census tracts within the 5 km radius of Chevron Refinery, except for tract 7 (southeast San Pablo), have asthma rates above the 90th percentile. Low birth weights are also above the 90th percentile for tract 15 (Pullman and Park Plaza neighborhoods) and tract 16 (Santa Fe and Coronado). The unemployment rate is highest in tract 14 (Atchison Village), which falls above the 90th percentile.

[4] Website for CalEnviroScreen 4.0: https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-40

Figure C-19 – Percentiles for CES Composite Score and Selected CES Indicators in Census Tracts Near the Chevron Refinery

Table C-2 - Percentiles for CES Composite Score and Selected CES Indicators in Census Tracts Near the Chevron Refinery

	Indicator								
	Composite CES Score	**Asthma**	**Cardiovascular Disease**	**Education**	**Housing Burden**	**Linguistic Isolation**	**Low Birth-weight**	**Poverty**	**Unemployment**
Tract 1	70-80	90-100	60-70	20-30	20-30	30-40	70-80	10-20	0-10
Tract 2	90-100	90-100	70-80	90-100	80-90	90-100	80-90	70-80	40-50
Tract 3	80-90	90-100	70-80	60-70	70-80	60-70	80-90	30-40	50-60
Tract 4	80-90	90-100	80-90	80-90	30-40	80-90	60-70	70-80	70-80
Tract 5	70-80	90-100	80-90	70-80	60-70	60-70	80-90	60-70	50-60
Tract 6	80-90	90-100	70-80	80-90	60-70	60-70	30-40	50-60	30-40
Tract 7	80-90	80-90	60-70	80-90	80-90	90-100	70-80	70-80	60-70
Tract 8	80-90	90-100	70-80	90-100	70-80	80-90	40-50	70-80	70-80
Tract 9	60-70	90-100	60-70	80-90	60-70	80-90	40-50	60-70	30-40
Tract 10	70-80	90-100	40-50	90-100	40-50	60-70	50-60	70-80	40-50
Tract 11	90-100	90-100	80-90	80-90	50-60	70-80	80-90	80-90	60-70
Tract 12	80-90	90-100	70-80	80-90	80-90	80-90	80-90	80-90	80-90
Tract 13	50-60	90-100	50-60	70-80	30-40	70-80	40-50	60-70	60-70
Tract 14	90-100	90-100	70-80	80-90	80-90	60-70	80-90	70-80	90-100
Tract 15	80-90	90-100	50-60	70-80	70-80	60-70	90-100	80-90	60-70
Tract 16	90-100	90-100	50-60	80-90	80-90	70-80	90-100	80-90	50-60
Tract 17	70-80	90-100	70-80	30-40	30-40	40-50	50-60	50-60	70-80

Historical Monitoring Stations & Monitoring Data

The locations of existing air quality monitors and historical data from those monitors are important considerations when establishing new monitoring sites. Table C-3 summarizes the recent history of air monitoring in the area, and Figure C-20 shows the location of monitoring stations.

Chevron monitors H_2S and SO_2 as part of its Ground-Level Monitoring (GLM) network. This type of monitoring is required at all five Bay Area refineries by Air District Regulation 9, Rule 1 and Regulation 9, Rule 2.[5,6] The Air District oversees the monitoring conducted by the refineries, including conducting site evaluations and performance audits of the monitors. Measurements in excess of rule limits are reviewed and investigated by Air District staff. Currently, Chevron operates three stations that monitor both H_2S and SO_2. Meteorological monitoring is also performed at one station. Chevron also operates fenceline monitoring for compliance with Air District and EPA requirements. In addition, Chevron operates three community monitoring stations (CMS) as part of an agreement with the City of Richmond; however, recent complete datasets were not available for these stations for detailed analysis.

In addition to the refinery GLM network, the Air District currently operates three monitoring stations in the area, which measure different air pollutants depending on the station. The Air District's monitoring station in San Pablo (at Rumrill Boulevard and Market Avenue) measures for most criteria air pollutants as well as air toxics.[7]

Table C-3 – Air Quality Monitoring Near the Chevron Refinery

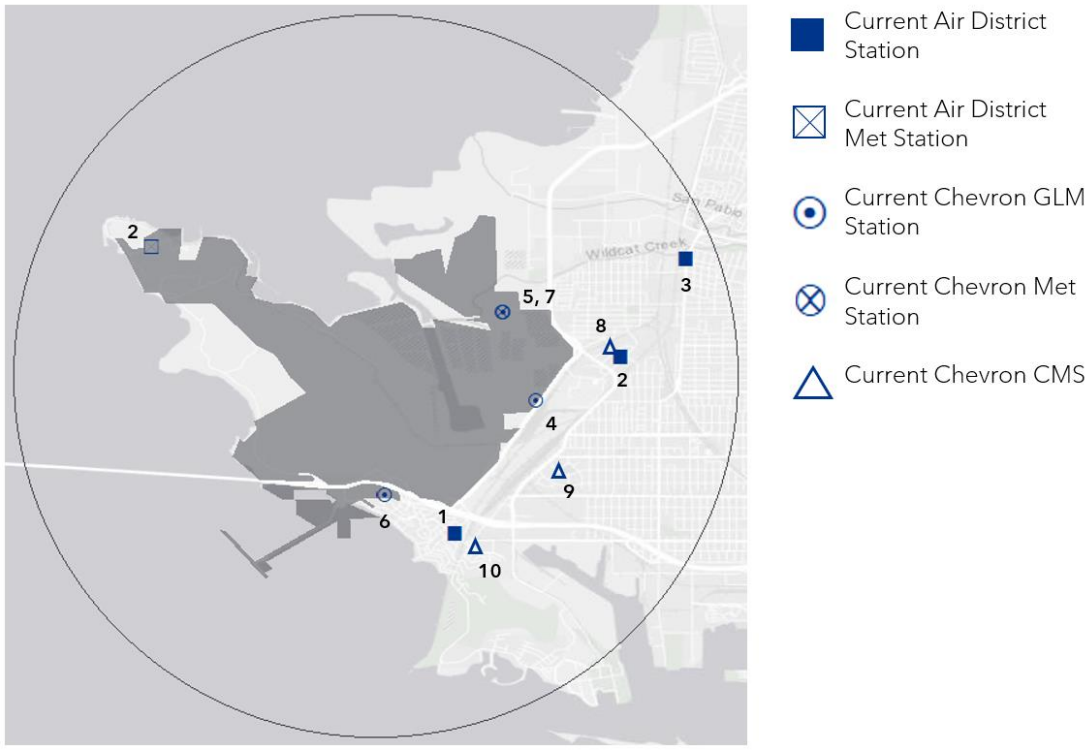
Station (map label)	Operator	Parameters Measured
BAAQMD-Point Richmond (1)	AQMD	H_2S
BAAQMD-Richmond-7th St (2)	AQMD	Air Toxics, H_2S, SO_2
BAAQMD-San Pablo-Rumrill (3)	AQMD	Air Toxics, CO, NO, NO_2, O_3, PM_{10}, $PM_{2.5}$, SO_2
Chevron-Castro (4)	Chevron (GLM)	H_2S, SO_2
Chevron-Gertrude (5)	Chevron (GLM)	H_2S, SO_2,
Chevron-Golden Gate (6)	Chevron (GLM)	H_2S, SO_2
Chevron-Met Station (7)	Chevron (GLM)	Meteorology
Chevron-North Richmond (8)	Chevron (CMS)	Black Carbon, $PM_{2.5}$, H_2S, Ammonia, VOCs, Meteorology
Chevron-Atchison Village (9)	Chevron (CMS)	
Chevron-Point Richmond (10)	Chevron (CMS)	

[5] Air District Regulation 9, Rule 1: Sulfur Dioxide: https://www.baaqmd.gov/rules-and-compliance/rules/reg-9-rule-1-sulfur-dioxide

[6] Air District Regulation 9, Rule 2: Hydrogen Sulfide: https://www.baaqmd.gov/rules-and-compliance/rules/reg-9-rule-2-hydrogen-sulfide

[7] The Air District has operated additional air monitoring stations in the area in the more distant past; they are not included here as the data are less relevant to the present analysis.

Figure C-20 – Location of Current and Former Monitoring Stations Near the Chevron Refinery



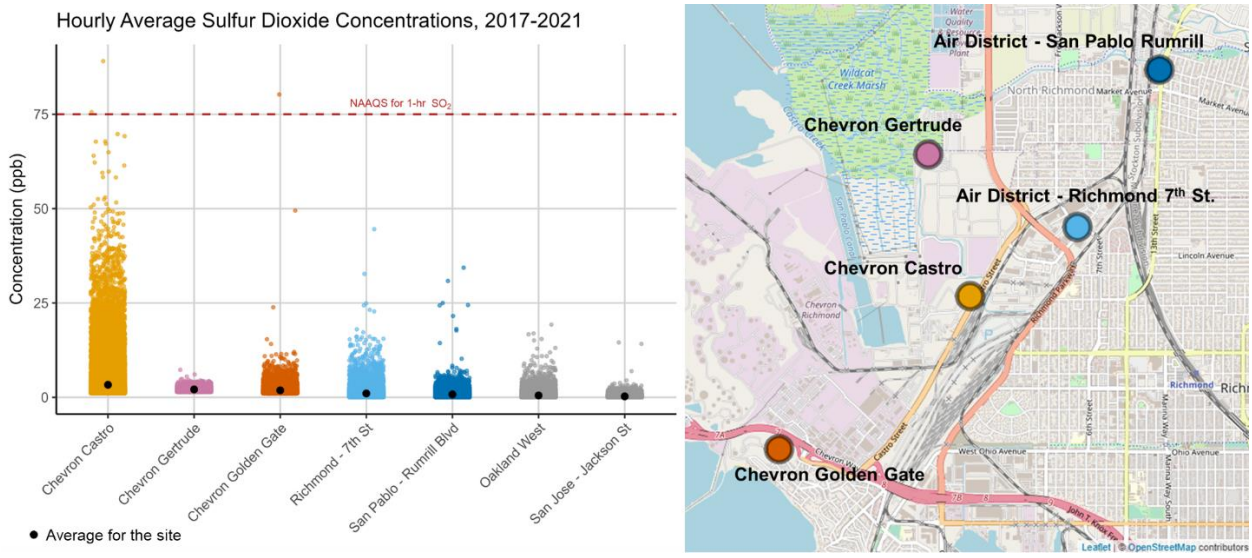
Note: See Table C-3 for the names corresponding to the numbered labels

Air monitoring data were evaluated in several ways as part of the ongoing implementation of Assembly Bill 617[8] in the Richmond-North Richmond-San Pablo area, which included a Community Air Monitoring Plan (CAMP)[9] and a Community Emissions Reduction Plan (CERP). The CAMP included several air monitoring projects designed to help inform on different air quality concerns and data needs. Selected analyses of air monitoring data and resulting findings from those efforts are highlighted below, and more details can be found in Chapter 5 of the CERP and Appendix D of the CERP.[10, 11]

A review of historical hourly SO_2 and H_2S measurements at monitoring stations in the area around the Chevron refinery over the period 2017 to 2021 shows that concentrations have been low generally, but occasional higher concentrations do occur, and variability is noted in the data from station to station. Figure C-21 shows distributions of hourly SO_2 concentrations by monitoring station, where each smaller dot represents an hourly SO_2 concentration, and the larger black dot represents the three-year average concentration. The data distributions are color-coded to match the station locations on the adjacent map.

[8] CARB website for the AB 617 Community Air Protection Program: https://ww2.arb.ca.gov/capp
[9] Air District website for the Path to Clean Air CAMP: https://www.baaqmd.gov/community-health/community-health-protection-program/richmond-area-community-health-protection-program/community-air-monitoring
[10] The Path to Clean Air CERP: https://www.baaqmd.gov/~/media/files/ab617-community-health/richmond/2024/03252024-draft-final-plan-files/draft-final-ptca-plan-pdf.pdf?rev=290927ece4d64392be5331154929d111
[11] Appendix D: Air Monitoring of the CERP: https://www.baaqmd.gov/~/media/files/ab617-community-health/richmond/2024/03252024-draft-final-plan-files/d-air-monitoring-pdf.pdf?rev=4c6d6f5d1ac04bbe9dfaad2c79387a6e

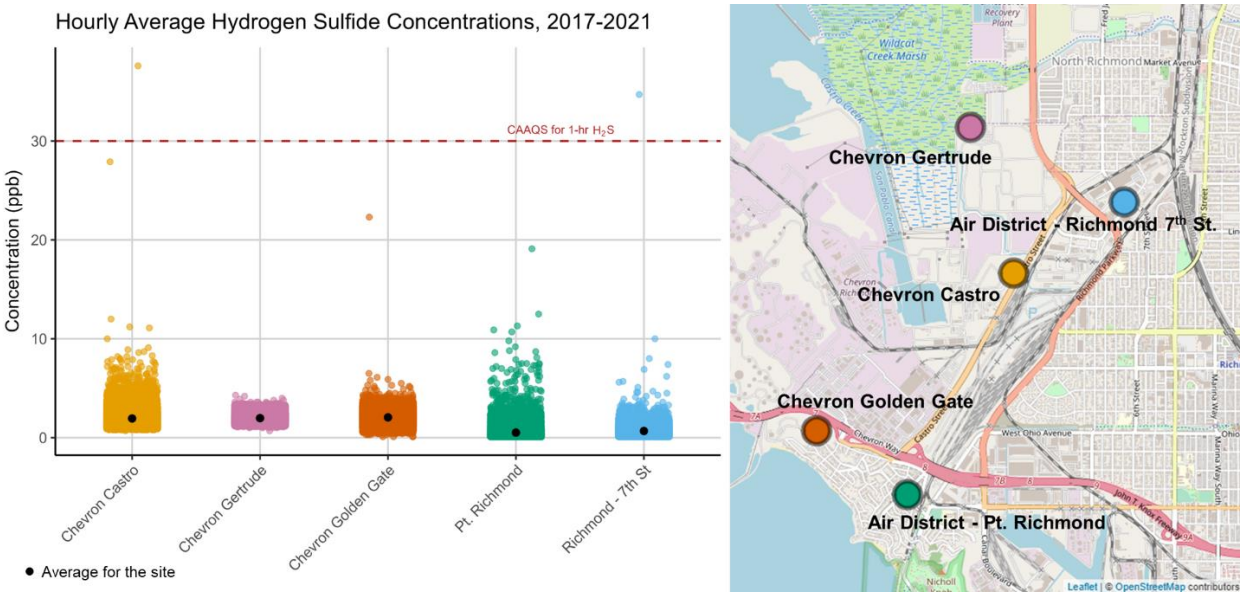
Figure C-21 – Historical SO_2 Concentrations and Map of SO_2 Monitor Locations



There were many more occurrences of relatively higher SO_2 concentrations at the Chevron-Castro GLM compared to other monitors, including some concentrations approaching and occasionally exceeding the National Ambient Air Quality Standard for SO_2 (however, refinery GLMs are not subject to the NAAQS since they operate within a facility fenceline.) There were fewer occurrences of higher SO_2 concentrations at the other monitoring stations. SO_2 concentrations at Air District monitoring stations, which are located outside the refinery fenceline, were comparatively lower and were well below the NAAQS. Data from the Oakland West monitoring station (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 stations, 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 stations compared to the San Jose-Jackson monitoring station. The higher SO_2 concentrations measured at the Chevron-Castro GLM occurred more frequently in the late spring, summer, and early fall, and particularly when winds were from the southwest (from the direction of the nearby Chemtrade facility and the Chevron bioreactor).

Figure C-22 is similar to the previous figure but shows measured hourly H_2S concentrations. 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. H_2S data from the refinery ground-level monitors and Air District monitoring stations were mostly below 30 ppb, though there have been isolated occurrences of higher concentrations near or exceeding 30 ppb.

Figure C-22 – Historical H_2S Concentrations and Map of H_2S Monitor Locations



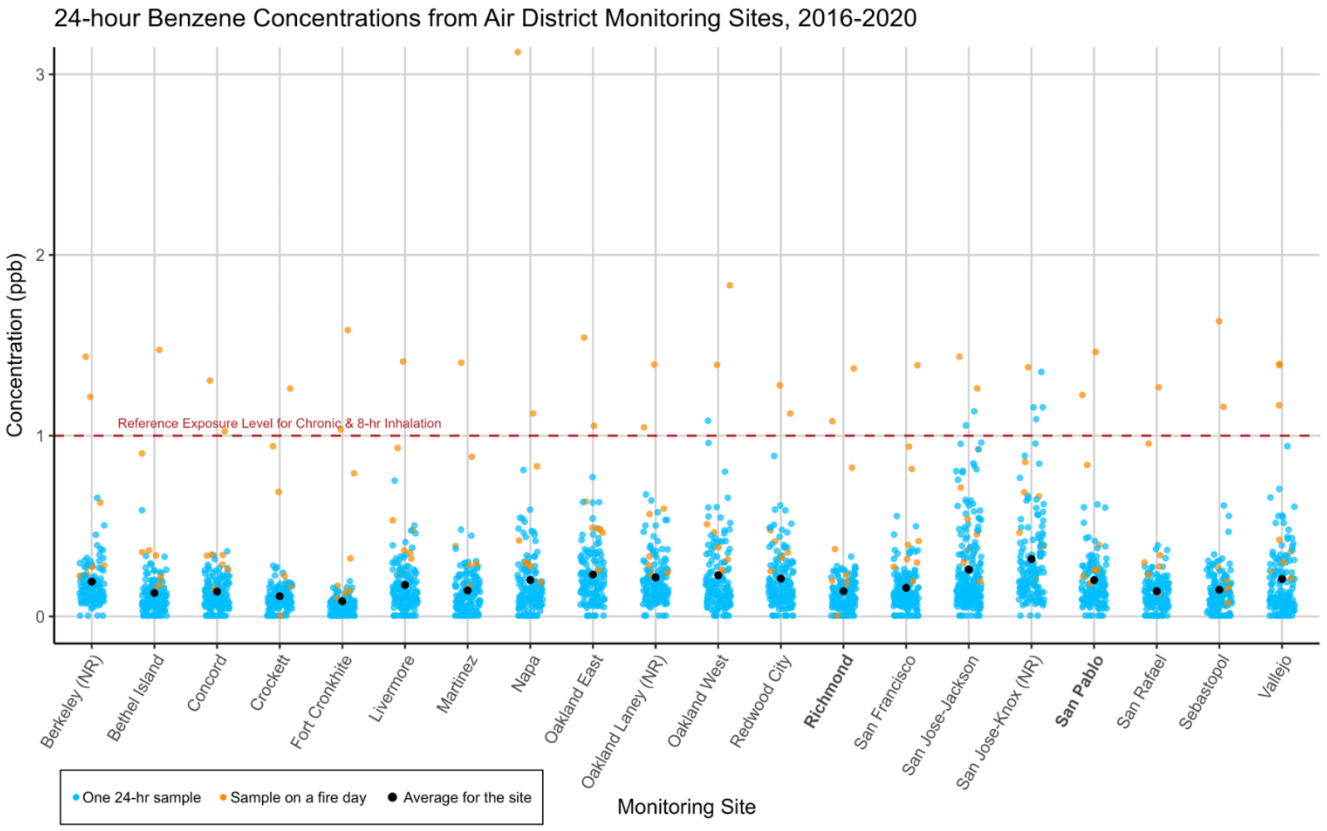
The three Chevron CMS noted previously also monitor for H_2S, but a complete dataset was not available for inclusion in this analysis. A cursory review of H_2S data from the Chevron CMS for 2021 and 2022 showed similar distributions as those shown for other nearby monitoring locations in Figure C-22, with more occurrences of relatively higher concentrations of H_2S observed at the Point Richmond CMS.

The Air District measures selected volatile organic compounds (VOCs), many of which are TACs, at its nearby San Pablo-Rumrill and Richmond-7th St. monitoring stations. These VOCs are measured by collecting air into a canister over 24 hours, and the collected samples are then analyzed at the Air District's laboratory. VOC samples are collected at these monitoring stations every twelfth day. VOCs can come from many kinds of facilities, operations, processes, and consumer products, as well as smoke from wildfires and other combustion.

Measurements for selected VOCs from Air District monitoring stations from 2016 to 2020 are provided below in Figure C-23 (benzene), Figure C-24 (toluene), and Figure C-25 (1,3-butadiene). Benzene and 1,3-butadiene are among the five compounds found to be responsible for more than 90% of the cancer risk attributed to emissions as part of the previously mentioned CARE study. Toluene shares similar sources to benzene and is now often used as a replacement for benzene in certain products, such as solvents.

Most of the measured benzene concentrations have been below 0.5 ppb across the Air District's monitoring network (Figure C-23), which is below the California Office of Environmental Health Hazard's chronic Reference Exposure Level (REL) for benzene of 1 ppb. Most measurements above 1 ppb occurred during periods of wildfire smoke. Some monitoring stations, including San Pablo, have recorded instances of relatively higher benzene concentrations (over 0.5 ppb) outside of periods of wildfire smoke, possibly indicating contributions from local emissions of benzene. Average benzene concentrations were slightly lower at the Richmond-7th St. monitoring station compared to the San Pablo monitoring station, and there were comparatively fewer individual measurements of higher levels of benzene at the Richmond-7th St. monitoring station.

Figure C-23 – Historical Benzene Concentrations



Several monitoring stations, including San Pablo, recorded more occurrences of relatively higher toluene concentrations compared to other stations in the network (Figure C-24). The highest 24-hour concentration of toluene measured throughout the network from 2016-2020 was at the San Pablo monitoring station, possibly indicating greater contributions from local emissions of toluene. While benzene and toluene share similar sources, toluene is now often used as a replacement for benzene in certain products, such as solvents. Although some of toluene concentrations measured at the San Pablo monitoring station were higher than in other typical urban areas, they were well below OEHHA's chronic and acute reference exposure levels (RELs) of 110 ppb and 1300 ppb, respectively.

The vast majority of 1,3-butadiene measurements (over 94% at Richmond 7th-St. and over 95% at San Pablo-Rumrill) yielded no detectable concentration. Of the few samples with detectable levels of 1,3-butadiene, concentrations were generally low (less than 0.2 ppb) and some of the highest concentrations occurred during periods of wildfire smoke (Figure C-25). Several other monitoring stations, such as San Jose – Jackson, San Jose – Knox, Oakland West, and Vallejo (among others) had more frequent occurrences of relatively higher concentrations of 1,3-butadiene. While 1,3-butadiene emissions result from petroleum refining operations, the bulk of 1,3-butadiene in the atmosphere comes from traffic, which is ubiquitous in the Bay Area urban environment.

Figure C-24 – Historical Toluene Concentrations

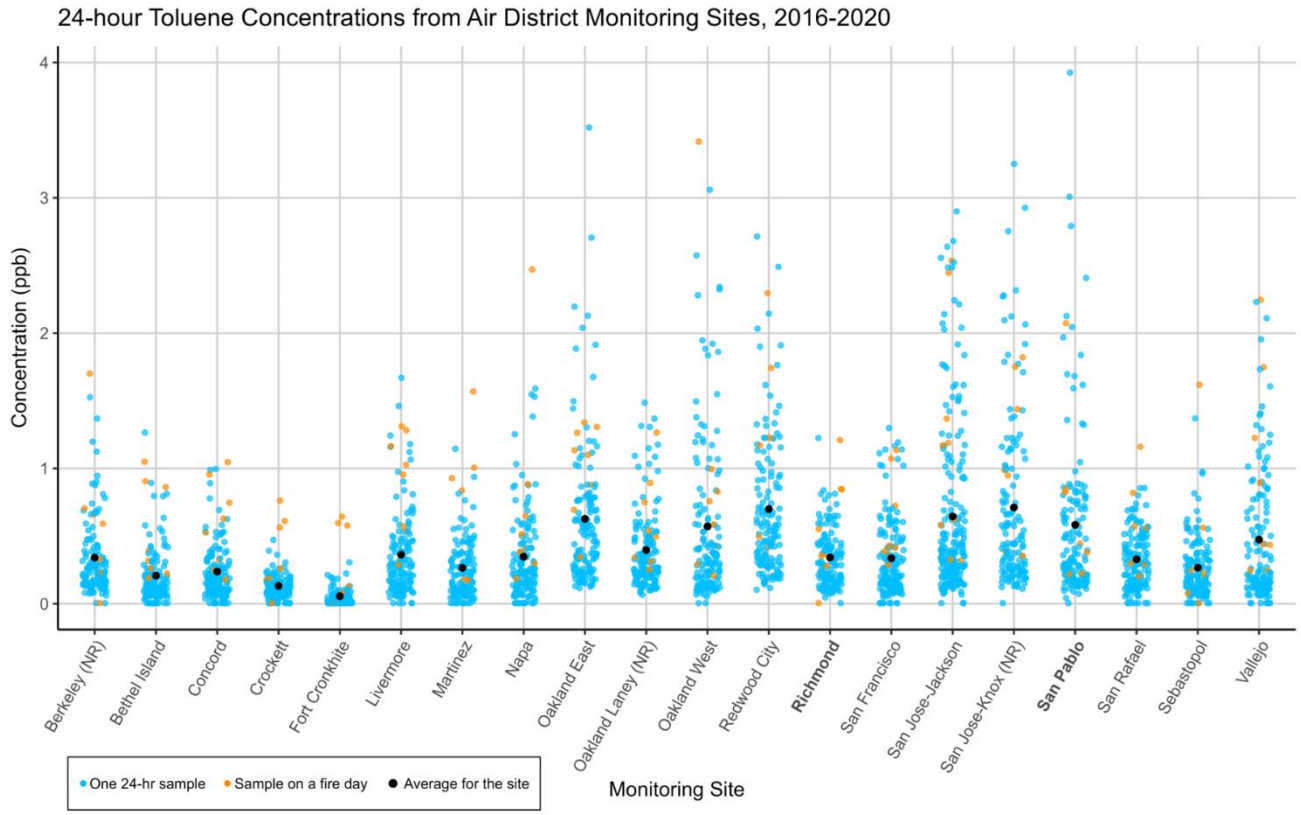
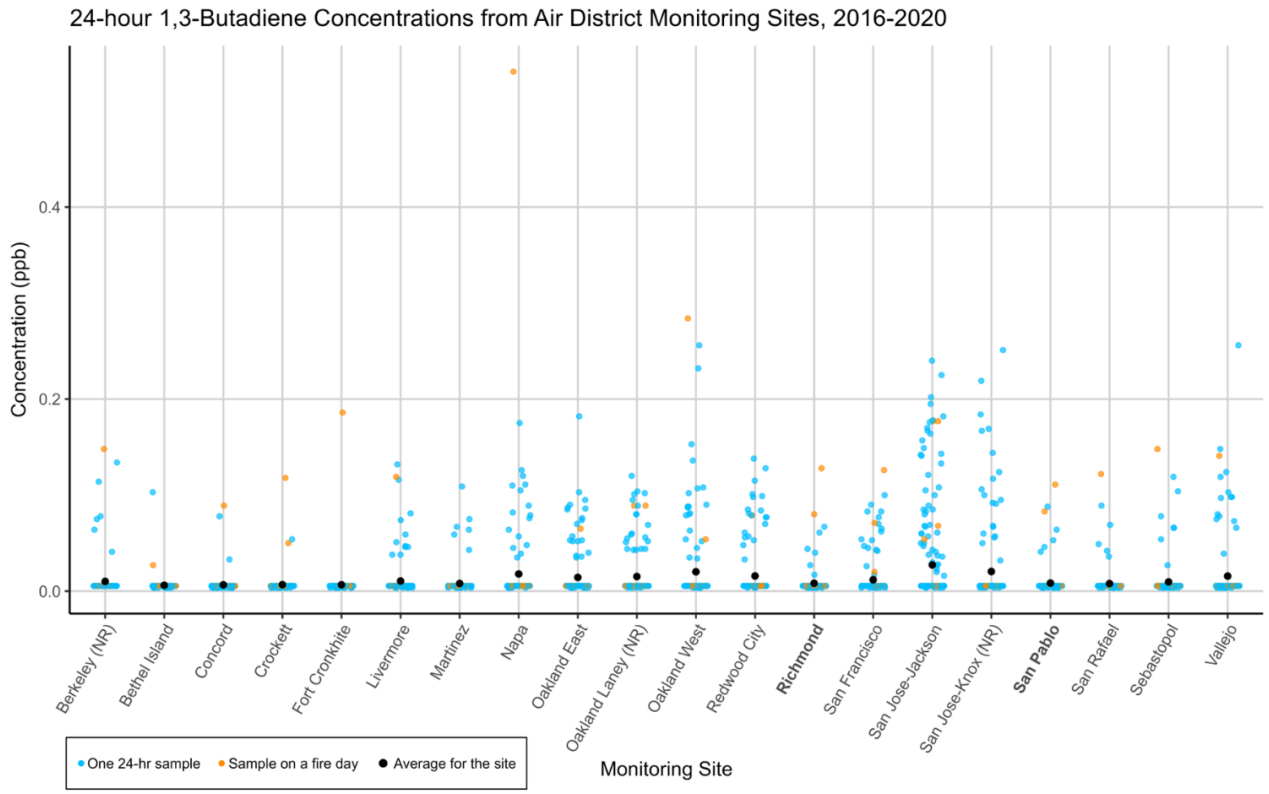
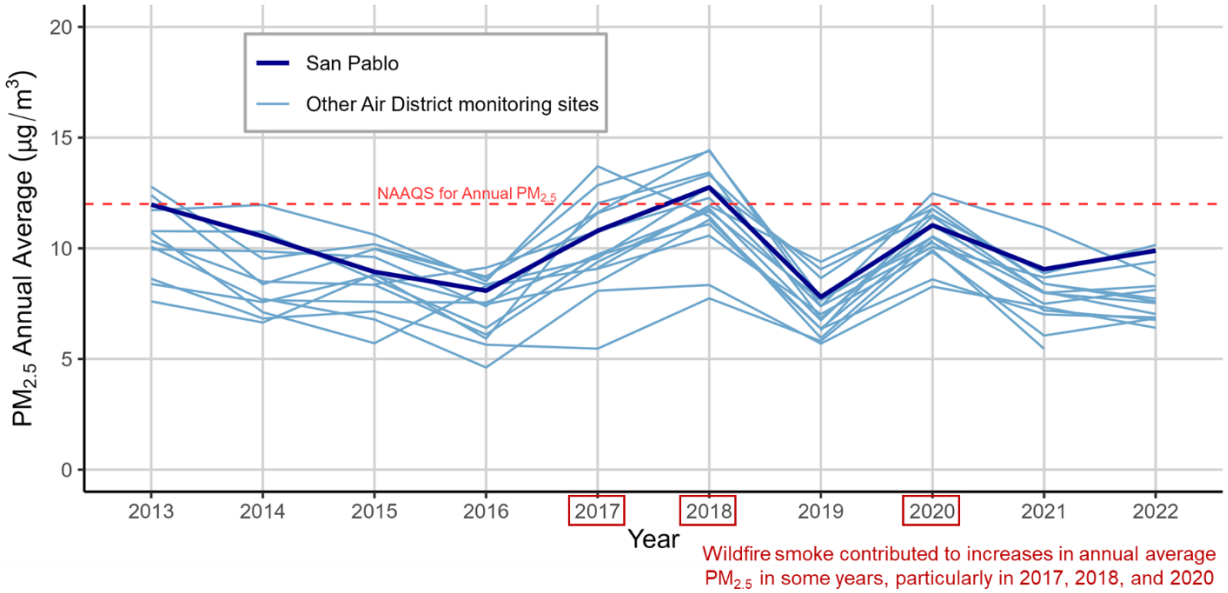


Figure C-25 – Historical 1,3-Butadiene Concentrations



Among the Air District's monitoring stations, San Pablo has historically often been one of the stations with higher annual average $PM_{2.5}$ concentrations (Figure C-26). Preliminary data that include the 2021-2023 period show that San Pablo has the highest design value (a statistic calculated using measured pollutant concentrations over the past three years for comparison with the NAAQS) for annual average $PM_{2.5}$ among Air District stations.

Figure C-26 – Annual Average $PM_{2.5}$ Concentrations at Air District Monitoring Stations



Evaluations of $PM_{2.5}$ data from Air District monitoring stations and from lower-cost $PM_{2.5}$ sensors in the Richmond-North Richmond-San Pablo area were included in Chapter 5 and Appendix D of the CERP, referenced previously. Lower-cost sensors collocated at the San Pablo monitoring station showed frequent occurrences of short-term peaks in $PM_{2.5}$ levels, possibly indicating contributions from localized, intermittent sources of $PM_{2.5}$ in the immediate vicinity.

The three Chevron CMS noted previously also monitor for $PM_{2.5}$, but a complete dataset was not available for inclusion in this analysis. A cursory review of $PM_{2.5}$ data from the Chevron CMS for 2021 and 2022 showed generally lower levels of $PM_{2.5}$ compared to the Air District's San Pablo monitoring station; however, there are differences in siting requirements and data validation procedures between the Chevron CMS and Air District monitoring stations, and therefore the data are not directly comparable.

Stakeholder Input

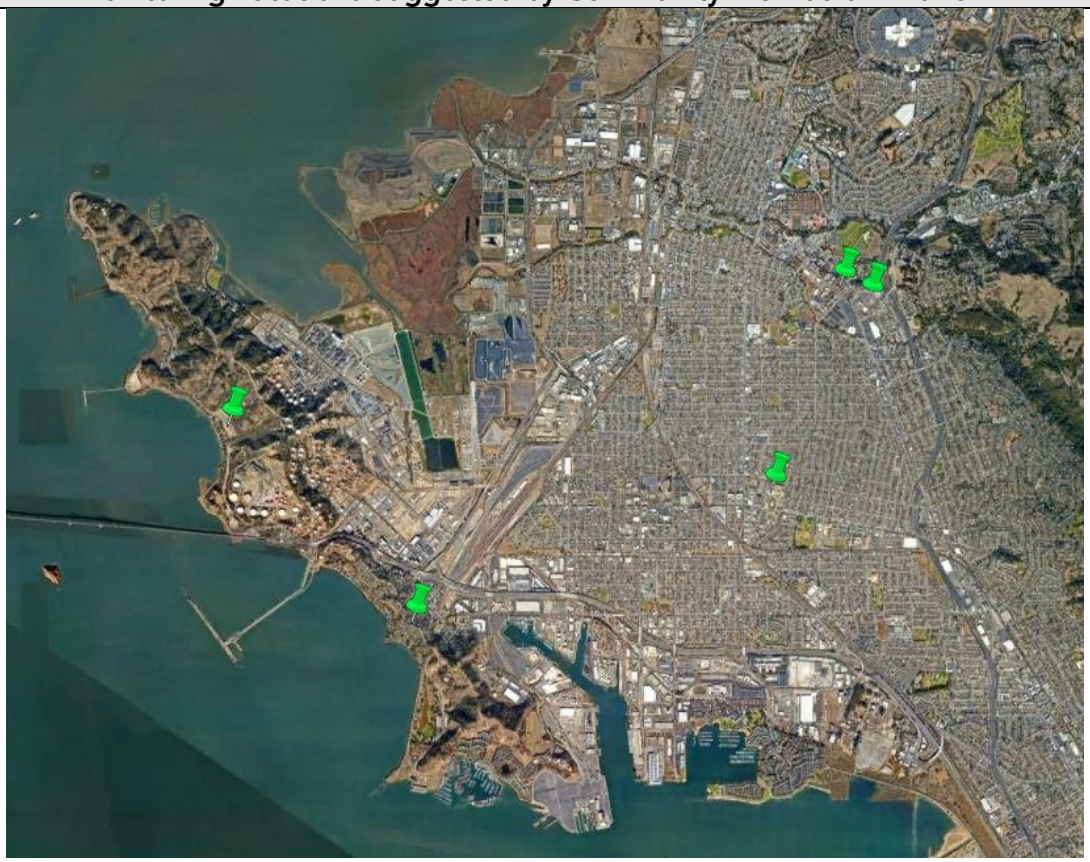
The Air District responds to and investigates all air pollution complaints. Air District staff reviewed complaint data between January 1, 2018, and December 31, 2020, for zip codes near the Chevron Refinery. During this period, the Air District received 1184 complaints in these zip codes. Table C-4 shows a breakdown of the number of complaints by zip code and by complaint type. A large majority (80%) of the complaints were related to odors. The communities of Richmond, North Richmond, and San Pablo are largely within the zip codes 94801, 94802, 94803, 94804, 94805, 94806, and 94807. The zip code with the highest number of total complaints was 94801, which includes the Chevron Refinery and adjacent neighborhoods in Richmond and North Richmond. Of the 1184 complaints across the selected zip codes, 230 were associated with the Chevron Refinery.

Table C-4 – Complaints by Zip Code and Type between January 1, 2018 and December 31, 2020

Zip Code	Asbestos	Dust	Indoor Fire	Outdoor Fire	Gas Station Nozzle	Odor	Other	Smoke	Train	Total
94801		14	5	2		377	23	44		463
94802		1				7		3		11
94803		2		1		9	6	1		19
94804	3	9	1			77	6	14		110
94805	1	3				24	5	8		41
94806	3	3		1		42	10	15		74
94807		5								5
94530	5					11	1	3		20
94564				1		7	0	1	1	10
94702	2	3		2		129		3		139
94706		1		1		28		5		35
94710	4	11				240		2		257
Total	18	52	6	6	0	951	51	99	1	1184

Figure C-27 shows suggested locations for future air monitoring as proposed by community members at a workshop held in Richmond in 2018. Of the five locations suggested, three are east of the facility, one is to the south, and one is near the facility to the west.

Figure C-27 – Monitoring Locations Suggested by Community Members in 2018



Recommended Priority Search Area for the Chevron Major Stationary Source Community Air Monitoring Station

As noted in the Executive Summary, no single fixed monitoring location will capture all the emissions from a given facility. Variability in the meteorological conditions coupled with differences in the characteristics (e.g., temperature or height) of emissions mean there is a chance that any area nearby could experience the impacts of the facilities, particularly for short duration emissions or incidents. In this case, several key factors stand out:

- Due to seasonal variability in wind patterns in the area around the Chevron Refinery, there is not any one neighborhood or area that is consistently downwind of the refinery.
    - While predominant onshore (southerly) winds would generally tend to transport refinery emissions northward and away from neighborhoods. However, southwesterly, westerly, and northwesterly winds also occur, which may transport emissions into adjacent parts of Richmond and North Richmond.
    - Lighter and more variable winds also occur frequently, particularly overnight, which can limit dispersion of pollutants.
- A review of air quality data from nearby air monitoring stations showed that:
    - The Air District's San Pablo monitoring station has historically measured relatively higher concentrations of $PM_{2.5}$ and certain air toxics compared to many other Air District monitoring stations, as well as higher concentrations of $PM_{2.5}$ compared to measurements from sensor networks in the Richmond area.
    - The Chevron-Castro GLM measured relatively higher SO_2 compared to other refinery GLMs and to Air District monitors. The Chevron-Castro GLM is immediately downwind of Chemtrade and the Chevron Refinery when winds are southwesterly. This monitor is within a half mile of Richmond's Iron Triangle neighborhood.
- Consistent with the historical meteorological data, a health risk screening assessment (HRSA) shows estimated cancer risk contours extending generally north and northwest of the refinery, with the highest risk contours over unpopulated areas. However, contours indicating lower risk levels do extend into most of the neighborhoods to the east and southeast of the refinery.
- Most of the census tracts near or adjacent to the refinery have high scores as overburdened communities. The tracts with the highest scores in CalEnviroScreen include those overlapping with Richmond's Iron Triangle, Atchison Village, Coronado, Santa Fe, and Shields-Reid neighborhoods and with North Richmond.
- The ZIP code that includes North Richmond and several Richmond neighborhoods immediately adjacent to the Chevron Refinery (94801) had the highest number air quality complaints received by the Air District compared to other ZIP codes in the Richmond area.

Regarding enhancing monitoring at an existing Air District monitoring station, the Air District's San Pablo-Rumrill multipollutant monitoring station is at the northeastern edge of recommended search area that was shown in Figure C-1. The San Pablo monitoring station has historically measured relatively higher concentrations of $PM_{2.5}$ and certain air toxics compared to many other Air District monitoring stations, and higher concentrations of $PM_{2.5}$ compared to measurements from sensor networks in the Richmond area. The Air District's existing Richmond-7th St. monitoring station is also within the recommended search area and is closer to the refinery than the San Pablo monitoring station. However, the Richmond-7th St. monitoring station measures only SO_2 and air toxics, and the

historical concentration data have been relatively low. Therefore, enhancing monitoring at the San Pablo monitoring station is a preferred option to enhancing monitoring at the Richmond-7th St. monitoring station.

Locating a new monitoring station within the recommended search area is also a suitable option. Census tracts overlapping with North Richmond and the Iron Triangle, Atchison Village, Coronado, and Santa Fe neighborhoods in Richmond have generally higher scores as overburdened communities (CalEnviroScreen composite scores over 90%) compared to the location of the Air District's San Pablo monitoring station. In addition, the ZIP code that includes North Richmond and several Richmond neighborhoods immediately adjacent to the Chevron Refinery (94801) had the highest number air quality complaints received by the Air District compared to other ZIP codes in the Richmond area. These locations are also in closer proximity to the Chevron Refinery compared to the Air District's existing multipollutant monitoring station in San Pablo.

While either option may be suitable, establishing a new air monitoring station can take a considerable amount of time as it requires identifying new candidate site locations, assessing those locations for logistical, siting, and other monitoring requirements, and installing and testing monitoring equipment. Therefore, it is recommended to proceed with enhancing monitoring at the existing San Pablo-Rumrill monitoring station, and when monitoring resources allow, subsequent monitoring at a new location within the recommended search area should be considered.