AB 617 Richmond-San Pablo Community Air Monitoring Plan

JULY 2020 – VERSION 2.1

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EXECUTIVE SUMMARY

In 2017, the California State Legislature passed Assembly Bill (AB) 617 to improve air quality for communities disproportionately affected by air pollution. AB 617 directs the California Air Resources Board (CARB), in collaboration with air districts, community groups, municipal governments, and other organizations, to identify candidate communities for air monitoring and air pollution reduction efforts. In accordance with AB 617 and as the government agency responsible for air quality in the San Francisco Bay Area, the Bay Area Air Quality Management District (Air District) evaluated data related to air quality and public health throughout the region and conducted extensive community outreach.

The Richmond-San Pablo air basin is characterized by a high density of large, complex pollution sources, resulting in a disproportionately high health burden experienced by local residents. Based on these factors, the Air District recommended that CARB select Richmond-San Pablo for a Community Air Monitoring Plan (Monitoring Plan). In September 2018, CARB approved Richmond-San Pablo for the development and implementation of a Monitoring Plan.

This document serves to summarize the community outreach, capacity building, and decision making undertaken to date and guide additional air monitoring in Richmond-San Pablo. In alignment with the community-focused framework emphasized in AB 617, the Air District cultivated diverse relationships and leveraged local wisdom to ensure community members designed and directed the Monitoring Plan process. In November 2018, the Air District held a summit attended by interested local groups, leaders, and neighborhood organizations that serve and represent people who live in Richmond and San Pablo. From this summit, a Community Design Team (CDT) formed and proposed that a larger Steering Committee direct the monitoring process. The CDT proposed an organizational structure, membership balance, and charter to guide community participation on the Steering Committee. At a February 2019 summit, the CDT shared their proposal with the public, solicited community feedback, and recruited Steering Committee members.

From more than 50 applications, the CDT selected a Steering Committee composed of 35 members, consistent with approved membership criteria. Following its first meetings in April 2019, the Steering Committee selected community members to join the Air District on a Co-Lead Team to provide infrastructure support and communicate with the Air District. At their subsequent monthly meetings, Steering Committee members learned more about their regional air quality, the health effects of degraded air quality, and different air monitoring methods. Together, they defined the boundary of the area for air quality monitoring and selected initial monitoring approaches to begin in summer 2019. The Steering Committee chose methods to identify areas with elevated levels of air pollution, evaluate differences among neighborhoods, assess exposure among vulnerable people, and provide real-time data to the public.

Building on this initial work, the Steering Committee considered more specific air pollution concerns and additional monitoring projects to help inform those concerns. A monitoring project focused on air toxics is expected to begin in Summer 2020. Data collected from recent and ongoing monitoring projects will help guide these efforts. This public information will ultimately serve to inform a Community Emission Reduction Plan (CERP) as well as other ongoing air quality improvement efforts outside of the AB 617 process.

CHAPTER 1: AB 617 AND COMMUNITY HEALTH PROTECTION PROGRAM OVERVIEW

Assembly Bill 617

In recognition of the persistent, unequal air pollution burden experienced by many California residents, the State Legislature signed Assembly Bill (AB) 617[1] into law in July 2017. Advancing California's leadership in environmental protection and public health stewardship, AB 617 mandates community-focused and community-driven projects to address air pollution disparities at the neighborhood level.

AB 617 is a response to advocates' concerns that the Cap and Trade Program (AB 398) did not address the persistent, elevated levels of air pollution in many communities. The goals of AB 617 are to promote sustained community participation, eliminate air quality disparities, reduce health burdens, and support continuous air quality evaluation and improvement. Two community-driven programs to reach these goals are the Community Air Monitoring Plan and the Community Emission Reduction Plan.

Community Health Protection Program and AB 617 Community Selection

The Air District established the Community Health Protection Program[2] (CHPP) to implement AB 617. CHPP partners with the community to employ proven and innovative strategies that improve community health by reducing exposure to air pollutants in neighborhoods most impacted by air pollution.

The Air District considered the following factors in identifying Bay Area communities for AB 617:

- Information provided by the community through written comment and eleven workshops held in candidate communities across the Bay Area from January through July 2018.
- Exposure to air pollution:
    1. Concentrations of ozone, particulate matter (PM) pollution, and toxic air pollutants from air quality measurements and modeling.
    2. Communities located near large sources of air pollution.
- Populations sensitive to the effects of air pollution exposure:
    1. High rates of disease related to poor air quality such as the prevalence of asthma, heart disease, low birth weights, premature mortality, or life expectancy.
    2. Socio-economic factors, such as poverty levels and unemployment rates.
    3. Sensitive populations including children, individuals with preexisting health conditions, the elderly, and location of schools, hospitals, and day care centers.
- Community capacity to participate in AB 617, including historical and on-going community air quality efforts.

The Air District evaluated these air quality, public health, and demographic data as well as existing community knowledge for each of the candidate communities. Based on this assessment, the Air District recommended that CARB select the Richmond-San Pablo area for a Community Air Monitoring Plan under

[1] Assembly Bill No. 617 (C. Garcia). Approved by the Governor July 26, 2017. https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180AB617

[2] Bay Area Air Quality Management District Community Health Protection Program website: http://www.baaqmd.gov/community-health/community-health-protection-program

AB 617[3]. CARB staff presented this recommendation to their Governing Board, which selected the first round of communities in September 2018. In total, CARB approved ten communities across the state for the first year of AB 617 implementation (Figure 1).

Figure 1. Communities selected for year one of AB 617. (CARB Press Release 18-51, September 27, 2018)[4].

Why Richmond-San Pablo for Air Monitoring?

Located in western Contra Costa County, the Richmond-San Pablo area encompasses most of the City of Richmond, communities north and east of the city, such as San Pablo, parts of El Cerrito, and several unincorporated communities like North Richmond. Richmond-San Pablo was recommended and selected as a Monitoring Plan community for several reasons. The area's approximately 150,000 residents are exposed to emissions from a high density of air pollution sources, which include large facilities, freeways, rail yards, a marine port, and many smaller sources. Notably, each of these is close to where people live and spend their time.

[3] The Air District's formal submittal of AB 617 community recommendations to CARB. https://www.baaqmd.gov/~/media/files/ab617-community-health/2018_0704_draft-submittal_master-pdf.pdf?la=en

[4] CARB Press Release 18-51, *CARB adopts blueprint for statewide community air protection in areas most impacted by pollution*, September 2018. https://ww2.arb.ca.gov/news/carb-adopts-blueprint-statewide-community-air-protection-areas-most-impacted-pollution

Many communities and neighborhoods in this area have been negatively impacted by historical injustice and include people experiencing low income and high health burden that increase vulnerability to environmental exposures. In general, people living in the Richmond-San Pablo area experience more asthma emergency room visits, higher rates of cardiovascular disease, greater unemployment, lower educational attainment, higher housing cost-burden, and lower life expectancy than in other areas of Contra Costa County. Levels of air pollution measured at existing long-term monitoring sites are within EPA's health-based standards and do not explain these observed health issues.

These factors together indicate a need for additional or different types of air monitoring data to add to historic and ongoing measurement studies to better understand the impact of local sources of air pollution on the area. The goal is to inform emissions reduction efforts and improve the health of the community through improved air quality and mitigation of people's exposure to air pollution. The Air District expects that communities initially selected for a Monitoring Plan will develop and implement CERP programs on a timeframe decided by the Steering Committee. This consideration will also depend on Air District and community resources, and the CARB Governing Board's approval of the community for CERP implementation. Outside of AB 617, The Air District continues to develop and implement emissions reduction strategies through rulemaking, changes in permitting processes, and grants and other incentives. More information on the Air District's community selection process, reasoning for selecting Richmond-San Pablo for monitoring plan development, and ongoing emission reduction efforts are summarized in the Air District's submittal document to CARB on AB 617 community recommendations[5]. CARB's AB 617 Community Air Protection Blueprint[6] outlines the criteria for development of community air monitoring plans and emission reduction programs.

[5] The Air District's formal submittal of AB 617 community recommendations to CARB. https://www.baaqmd.gov/~/media/files/ab617-community-health/2018_0704_draft-submittal_master-pdf.pdf?la=en

[6] California Air Resources Board, *Community Air Protection Blueprint*, October 2018. https://ww2.arb.ca.gov/our-work/programs/community-air-protection-program/community-air-protection-blueprint

CHAPTER 2: BUILDING COMMUNITY PARTNERSHIPS

The Air District worked with community leaders to develop and implement a comprehensive community engagement framework that shared power and placed decision-making control with community members. In summer 2018, the Air District sought to identify community partners to co-lead this process with the Air District in the Richmond-San Pablo area that could help develop a Monitoring Plan. A group of concerned community members formed a Community Design Team to develop and implement an early public engagement framework. Using this framework, the Community Design Team began to shape the iterative, community-led process that has been the foundation for an air Monitoring Plan in Richmond-San Pablo (Figure 2).

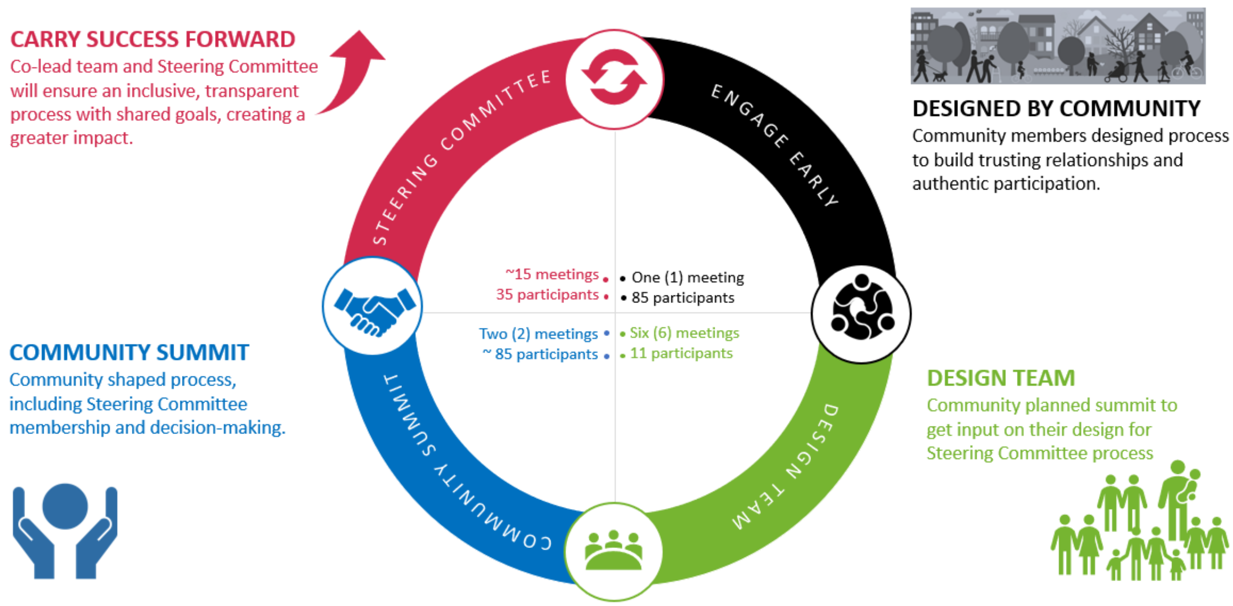

Figure 2. Outline of the community-led process for developing a Monitoring Plan in Richmond-San Pablo.

Community Design Team

In November 2018, the Air District held a meeting to launch the community-developed effort. At this meeting the Air District committed to leverage the power and wisdom of the Richmond-San Pablo community, to build trusting relationships and an authentic process for participation. Approximately 85 people attended that meeting and shared ways to ensure that development of the Monitoring Plan remained community-driven and grounded in community needs. Community representatives were offered an opportunity to join a Community Design Team (CDT). After receiving numerous applications, eleven community members were selected for the CDT who fit the criteria of either living in the Richmond-San Pablo area or working for a non-profit community-based organization (CBO) serving the area.

The purpose of the CDT was to design and implement a community-driven process to ensure widespread and diverse community participation on a Steering Committee. For three months, the CDT developed a proposed Steering Committee organizational structure, membership balance, and charter to guide expectations for participation. In February 2019, the CDT held a community summit to share their proposal with the public, learn about areas for improvement, and recruit Steering Committee members.

Community Summit Design Team meeting

Steering Committee and Co-Lead Team

The Steering Committee is the multi-stakeholder decision-making group that directs the discussion and development of the monitoring plan. Its membership is intended to reflect the diverse makeup of the Richmond-San Pablo Area and bring together an inclusive group of stakeholders with community knowledge and technical and scientific expertise. The CDT selected 35 people from a range of organizations and sectors to serve on the Steering Committee (Appendix A). Steering Committee members were chosen from more than 50 applications submitted after the February 2019 community summit.

To ensure that the air Monitoring Plan remains community-driven and grounded in community need, the CDT agreed that at minimum over half of the Steering Committee should represent people who live in the area, including individuals or those who represent a group of individuals, such as members of neighborhood councils, and non-profits serving people who live in the area. Because pollution exposure may vary from block to block, the CDT also strived for geographical representation.

The Steering Committee is supported by a Co-Lead Team (co-leads) comprised of five community leaders and the Air District (Appendix A). Nominated by the CDT and elected by the full Steering Committee, the co-leads provide infrastructure support to the Steering Committee and the air monitoring plan development. The community co-leads are local to the Richmond-San Pablo Area and are responsible for providing necessary background materials for steering committee members, developing meeting agendas, coordinating with the facilitation team (duties described below), and leading Steering Committee activities. The co-leads also provide community engagement and technical support to the Steering Committee and welcome comments and questions at: RichmondCoLeads@gmail.com. Agendas and meeting materials are made available at the Air District Richmond Area Community Health Protection Program website[7].

[7] Air District, Richmond Area Community Health Protection Program. Available online: http://www.baaqmd.gov/community-health/community-health-protection-program/richmond-area-community-health-protection-program

Richmond-San Pablo Steering Committee meeting

The CDT developed a charter to set the direction, schedule, and ground rules to guide the Steering Committee as it develops a community monitoring plan aligned with CARB's AB 617 Blueprint. The charter documents the balance and criteria for Steering Committee membership, expectations for participation, how Steering Committee decisions are made, and the voting procedures used. It includes a Participation Agreement that each Steering Committee member has signed. The charter was formally adopted by the Steering Committee in April 2019 and amended in May 2019 (Appendix B).

Decision-making does not proceed without a quorum of members. A quorum is reached when at least 51% of the Steering Committee (18 members) are present and of those present, 51% are individuals who represent people or groups of people who live in the Richmond-San Pablo area, including non-profits and Community Based Organizations that serve people living in the area. A neutral facilitator, selected by the CDT, supports the Steering Committee by assisting with its overall organization, ensuring orderly and focused meetings, resolving conflicts, and helping reach consensus in keeping with goals and objectives of the charter. Achieving full consensus of the Steering Committee is not always possible. In the event of an impasse, the co-leads decide how the process should proceed. For example, they may decide to bring additional information to the Steering Committee, invite content experts to present, form a task force or another strategy to help the Steering Committee reach a decision. If the co-leads do not agree on a path forward, then the action in question will not proceed. Steering Committee members who do not agree with a majority consensus on a decision may submit a position statement to the co-leads.

The Steering Committee typically meets once per month and the co-leads meet weekly. The co-leads make every effort to make Steering Committee meeting agendas and materials available for review one week before each Steering Committee meeting. Steering Committee meeting summaries are also made available as soon as possible following each meeting on the Richmond Area Community Health Protection Program website.

The Air District is the main point of contact regarding the monitoring plan and its implementation. Questions or comments regarding the plan can be sent to AB617info@baaqmd.gov, and from there the Air District will relay messages to community partners and monitoring project leads as needed.

CHAPTER 3: AREA DESCRIPTION AND EXISTING DATA

The Richmond-San Pablo study area established by the Steering Committee includes most of the cities of Richmond and San Pablo and adjacent communities such as North Richmond, Montalvin, parts of Tara Hills, El Sobrante and the Richmond Annex (Figure 3). The study area was chosen so that it includes the major sources of pollution and areas where the population experiences disproportionately high health burden. This boundary is a starting point for investigation and new data and analyses may identify sources of pollution or monitoring needs outside this initial boundary.

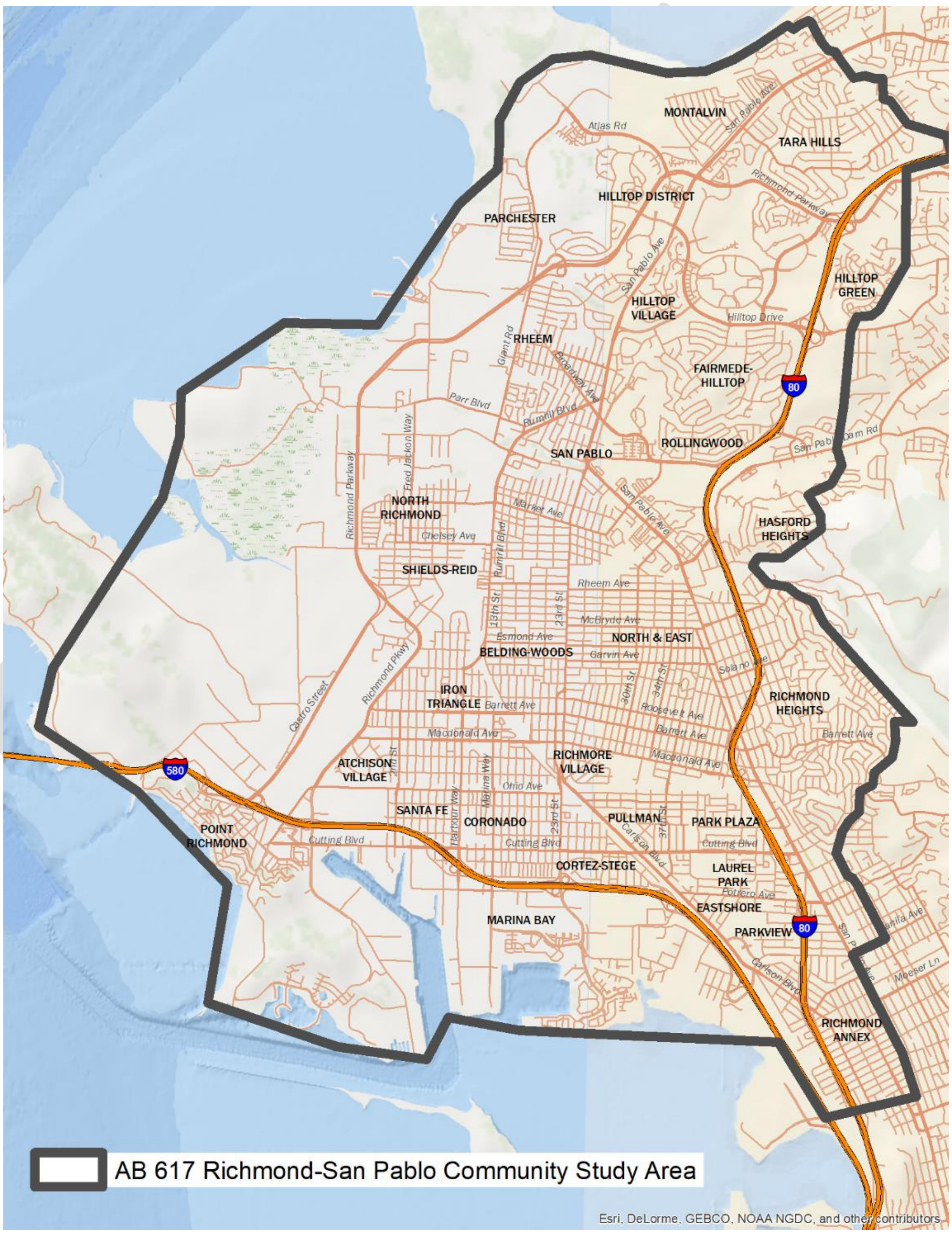

Figure 3. Map of the Richmond-San Pablo study area for developing a community air monitoring plan.

Residents in the Richmond-San Pablo area are exposed to a substantial and complex mix of air pollutants. Industrial sources of air pollution include a petroleum refinery, a chemical plant, a coal and petroleum coke terminal, organic liquid storage and distribution facilities, wastewater treatment plants, a landfill, organic waste metal facilities, and industrial and manufacturing plants of various sizes. Also, numerous smaller sources of air pollution are located within residential areas, including auto body shops, paint shops, restaurants, and gas stations. Mobile sources contribute air pollution, including diesel PM, to the area as well, including traffic on high volume freeways such as I-80, I-580 and on roadways such as Richmond Parkway and San Pablo Avenue, truck operations related to large distribution facilities, seaport operations, railways, and railyards. In total, there are more than 200 permitted emissions sources distributed throughout the Richmond-San Pablo area (Figure 4). Estimates of the cumulative particulate matter and air toxics emissions from these permitted sources[8] were compiled by the Air District and provided to the Steering Committee.

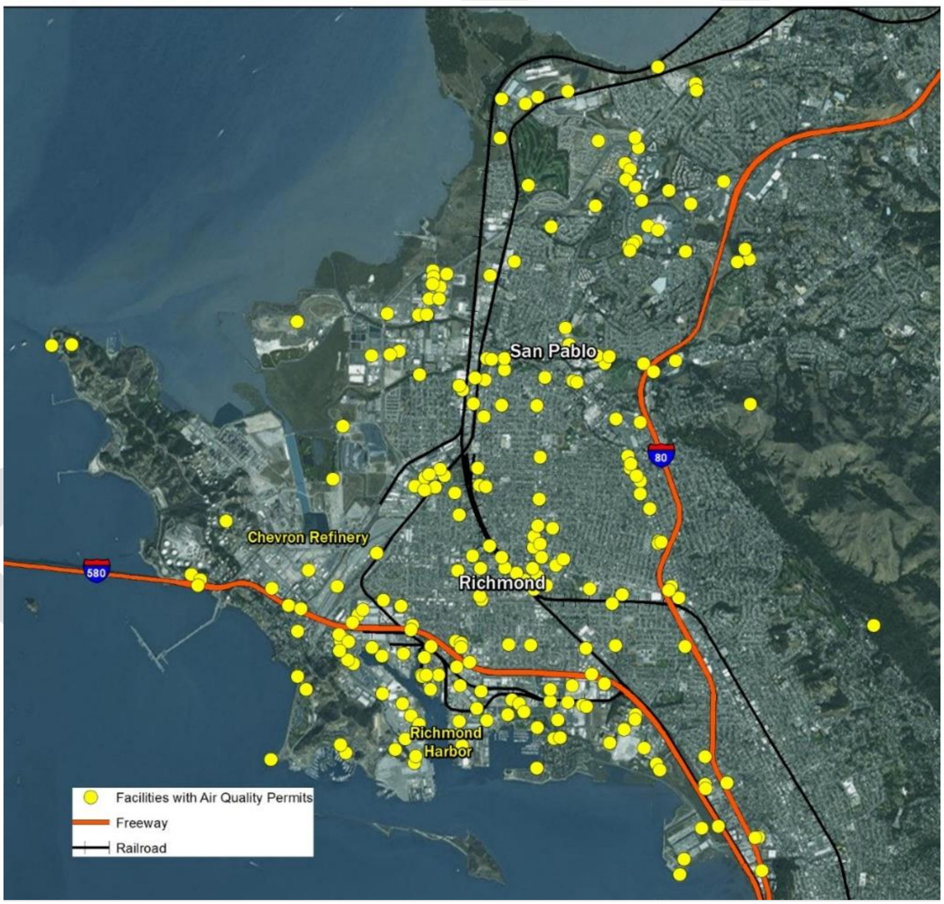

Figure 4. Locations of facilities with air quality permits, freeways, and railways in the Richmond-San Pablo area.

[8] Spreadsheet containing permitted sources in the Richmond-San Pablo area and their emissions inventories: http://www.baaqmd.gov/~/media/files/ab617-community-health/richmond/061919-mtg-files/7-facilities-and-total-emissions-by-pollutant_20190612-xlsx.xlsx?la=en.

Existing Air Monitoring in the Richmond-San Pablo Area

Prior to this program, long-term air monitoring sites in the Richmond-San Pablo study area have been operated by the Air District or by the Chevron Refinery (Figure 5). These sites use a range of instruments to monitor for various air pollutants, and are operated to meet different monitoring objectives, including different siting characteristics and data quality objectives (Table 1).

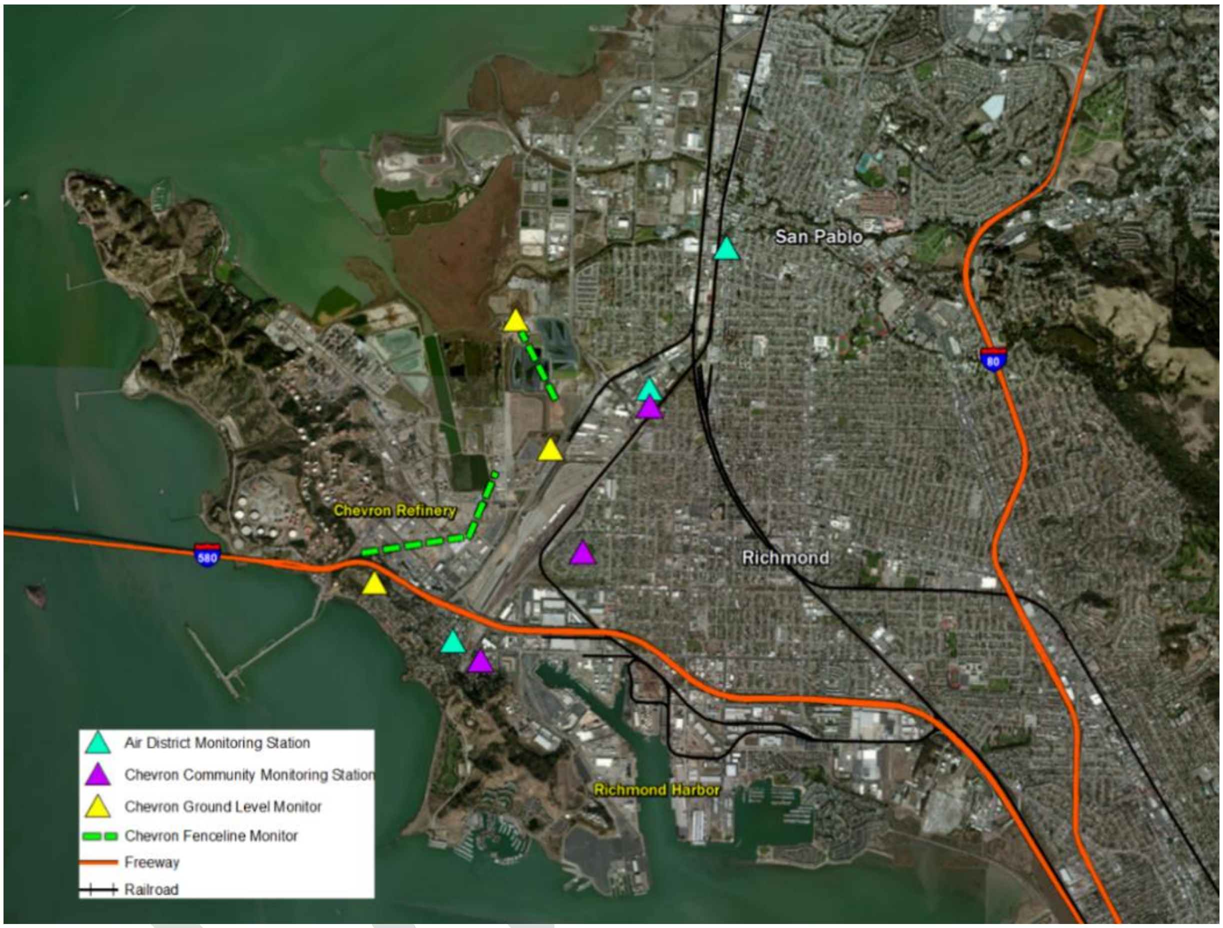

Figure 5. Map of Air District-operated and Chevron-affiliated air monitoring stations in Richmond-San Pablo

The Air District air monitoring sites in the Richmond-San Pablo area are part of a network of air monitoring stations throughout the Bay Area. Historically, air monitoring stations in the Richmond-San Pablo area have been sited to measure refinery-related pollutants or to characterize air quality in an urban area where many people live. Most sites in this network are located to estimate typical population exposure and demonstrate compliance with the National and California Ambient Air Quality Standards, including the Air District's San Pablo site (on Rumrill Road), which measures many pollutants. However, some sites are intentionally located near a single large source of air pollution, such as the Richmond-7th Street site and the Point Richmond site. These source-oriented sites measure pollutants that are expected to be emitted at ground level by petroleum refining operations, including H_2S, SO_2, and air toxics (VOCs) at Richmond-7th Street and H_2S at Point Richmond.

Chevron operates three Ground-Level Monitors (GLMs) to comply with Air District Rule 9-1[9] and 9-2[10]. These GLMs measure specifically for sulfur dioxide (SO_2) and hydrogen sulfide (H_2S), two pollutants commonly associated with refinery-related operations. In 2013, Chevron began operating fenceline monitoring that provides real-time measurements of SO_2, H_2S, and other pollutants as they cross the refinery fenceline. Also in 2013, in an agreement with the City of Richmond, Chevron installed community monitoring stations[11] in Point Richmond, Atchison Village, and North Richmond to provide measurements that can help characterize pollution levels in neighborhoods adjacent to the refinery.

More recently, Chevron is revising its fenceline monitoring to comply with Air District Regulation 12, Rule 15 (Rule 12-15)[12], adopted in 2016, as well as the U.S. EPA's Refinery Maximum Achievable Control Technology (MACT) Rules[13,14]. Rule 12-15 requires that Bay Area refineries submit and implement a fenceline air monitoring plan, which describes the equipment to be used to monitor, record, and report levels of specific pollutants; the siting, operation, and maintenance of the monitoring equipment; and procedures for implementing data quality assurance and quality control. Chevron submitted its fenceline air monitoring plan[15] to the Air District in 2017, which has been tentatively approved pending final approval of a complete Quality Assurance Project Plan (QAPP). Final approval of the QAPP is anticipated once the monitoring systems are fully operational and adequate quality assurance metrics have been established and incorporated into the quality management program to ensure accurate data reporting. Some of the required open-path fenceline monitors are currently operating and displaying data on Chevron's Richmond air monitoring website. The Air District granted operational extensions for the remaining required open-path system components until August 31, 2020, due to delays caused by construction permitting, installation, and instrument malfunction. As part of this extension, the Air District is requiring Chevron to perform additional analysis on the refinery MACT samples to include toluene, ethylbenzene, and xylene, in addition to MACT-required benzene.

In addition to the monitoring described above, the Berkeley Environmental Air quality and CO_2 Network[16] (BEACO_2N) consists of several monitoring nodes across the East Bay, including some in the Richmond area. The Air District has been working to better understand what data availability and coverage from this network and other recent air quality research efforts.

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

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

[11] Data from the Chevron-Richmond community monitors and the Chevron fenceline monitors are available in real-time at https://www.richmondairmonitoring.org/measurements.html.

[12] Air District Regulation 12 Rule 15. http://www.baaqmd.gov/rules-and-compliance/rules/regulation-12-rule-15--petroleum-refining-emissions-tracking

[13] 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

[14] U.S. EPA Petroleum Refinery Fenceline Monitoring Data. https://www.epa.gov/stationary-sources-air-pollution/slides-petroleum-refinery-fenceline-monitoring-data

[15] Air District Fenceline Monitoring Plans. http://www.baaqmd.gov/plans-and-climate/emission-tracking-and-monitoring/fenceline-monitoring-plans

[16] Description of BEACO_2N: http://beacon.berkeley.edu/overview/

Table 1. Ongoing monitoring conducted by the Air District or Chevron in the Richmond-San Pablo area at stations established prior to AB 617 implementation. Measurement abbreviations: ozone (O_3), carbon monoxide (CO), nitrogen oxide (NO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), hydrogen sulfide (H_2S), particulate matter (PM).

Monitoring Network	Station	Parameters Measured
Air District	San Pablo (Rumrill Blvd.)	O_3, CO, NO, NO_2, SO_2, PM_{10}[a], $PM_{2.5}$[b], Air Toxics[c]
	Richmond (7th Street)	SO_2, H_2S, Air Toxics[c]
	Point Richmond	H_2S
	Point San Pablo[d]	Meteorology
Chevron-Ground Level Monitoring	Chevron Castro	SO_2 and H_2S
	Chevron Golden Gate	SO_2 and H_2S
	Chevron Gertrude	SO_2, H_2S, Meteorology
Chevron-Richmond Community Monitoring	Atchison Village	Black Carbon, $PM_{2.5}$, H_2S, Air Toxics[c], Meteorology
	North Richmond	
	Point Richmond	
Chevron-Fenceline Monitoring	Along refinery fenceline	BTEX[e], H_2S, SO_2, Methane, Ethane, Propane, Butane, Pentane

[a] Particulate matter with diameter of 10 micrometers or less.

[b] Particulate matter with diameter of 2.5 micrometers or less.

[c] Air toxics are pollutants that cause or may cause cancer or other serious health effects and may exist as gases or particles. Specific compounds measured vary by site and are described in Section 5.6 of the Air District's 2018 Air Monitoring Network Plan.[15]

[d] The Air District's meteorological monitoring site at Point San Pablo was closed in January 2019. The Air District is working to identify a new location for this site near Point San Pablo. Meteorological measurements are described in more detail in Section 5.1 of the Air District 2018 Air Monitoring Network Plan[17]

[e] Benzene, toluene, ethylbenzene, xylene (collectively referred to as BTEX) are air toxics typically associated with petroleum operations. Xylene monitoring includes m-xylene, o-xylene, and p-xylene.

Monitoring Network Data and Limitations

Data provided by the Air District's regulatory monitoring network help characterize long-term air quality trends and can be compared to the health-based standards set by the EPA. Using EPA health-based standards[18] for annual average $PM_{2.5}$ and 24-hour average $PM_{2.5}$, $PM_{2.5}$ concentrations across the Bay Area have gradually declined and are below these standards except for recent increases in $PM_{2.5}$ – attributable largely to wildfire smoke in 2017 and 2018 (Figure 6 and Figure 7). This regulatory network, however, may not provide information relevant to all air quality concerns, and is likely not sufficiently dense to assess community-scale variations in air quality. New community-oriented monitoring required by AB 617 is intended to bridge this gap and better characterize local air quality in communities that have been historically overburdened with air pollution.

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[17] Air District 2018 Air Monitoring Network Plan. http://www.baaqmd.gov/about-air-quality/air-quality-measurement/ambient-air-monitoring-network

[18] Description of U.S. EPA's health-based standards: https://www.epa.gov/air-trends/air-quality-design-values

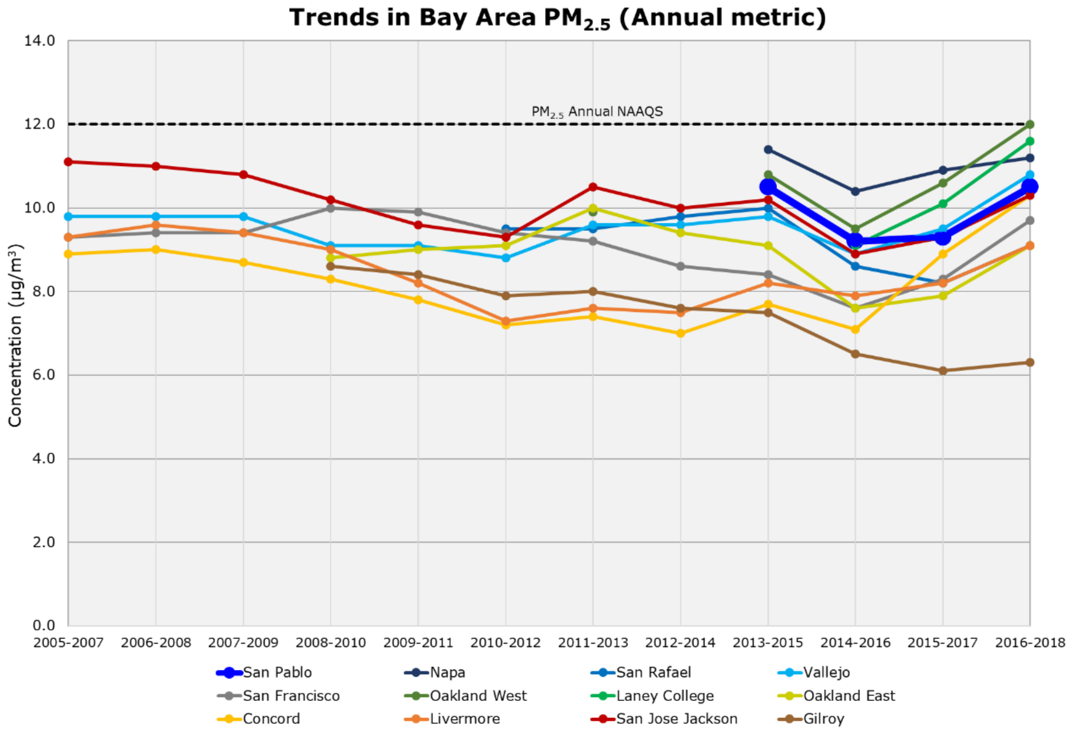


Figure 6. Trends in annual $PM_{2.5}$ at selected Air District stations. $PM_{2.5}$ monitoring at San Pablo did not begin until late 2012; thus, the first three-year data set available at San Pablo is for 2013-2015.

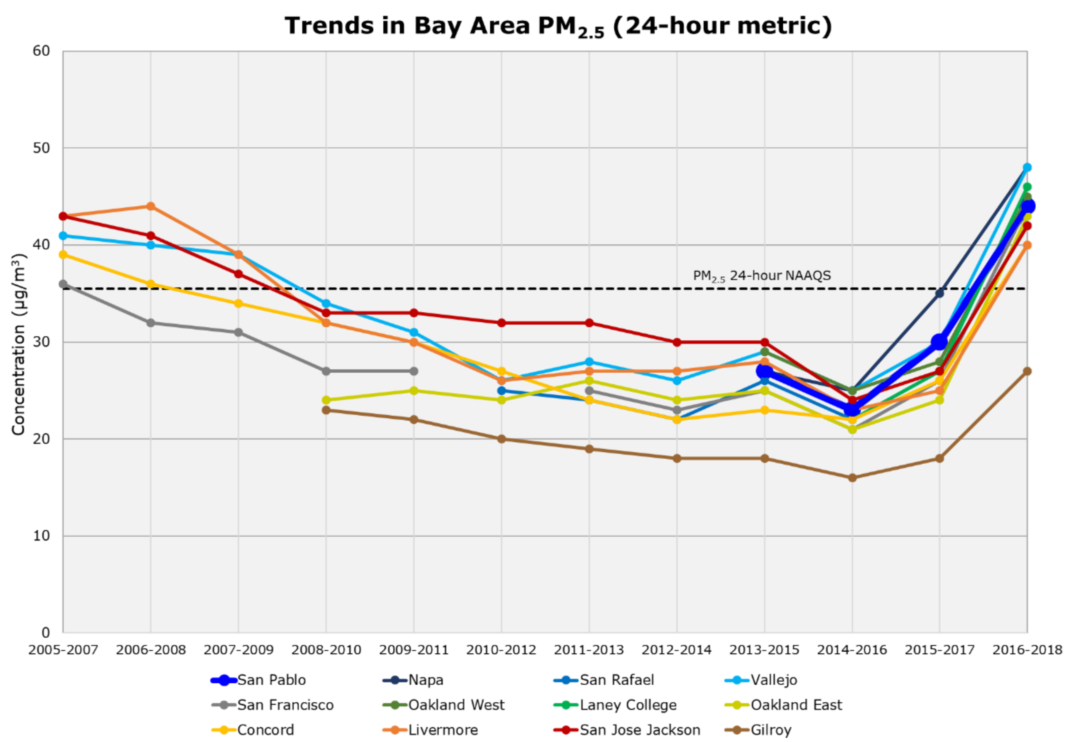


Figure 7. Trends in 24-hour $PM_{2.5}$ at selected Air District stations. $PM_{2.5}$ monitoring at San Pablo did not begin until late 2012; thus, the first three-year data set available at San Pablo is for 2013-2015.

$PM_{2.5}$ data are also available from the Chevron-Richmond Community Monitoring stations (Figure 8). Daily (midnight to midnight) average $PM_{2.5}$ concentrations in 2017 from those stations and the Air District's San Pablo station are shown to illustrate day-to-day variability. Most of the time, measured $PM_{2.5}$ levels at these stations were well below EPA's standard[19] for 24-hour $PM_{2.5}$ of 35 µg/m^3 and followed similar day-to-day patterns that reflect variations in regional air quality. Regional air quality is driven largely by pollution emissions from sources across the region, transport of pollution (within the region or into or out of the region), and weather conditions. Wildfire smoke events in autumn 2017 caused periods of pronounced increases in $PM_{2.5}$ across the Bay Area, including at all of the Richmond-San Pablo area sites, indicative of a regionwide event. There are other periods though where only one site showed notably higher $PM_{2.5}$ concentrations compared to the other sites (such as in February 2017 at North Richmond), possibly indicating impact from a local source. $PM_{2.5}$ levels also fluctuate considerably from season to season (Figure 9) and are typically higher in the Bay Area during the winter months either due to the combination of occasional stagnant weather patterns and increased emissions from residential wood burning or from more frequent weather patterns that bring air into the Bay Area from the Central Valley. As previously noted, wildfire smoke events caused significant increases in $PM_{2.5}$ in October 2017 and November 2018.

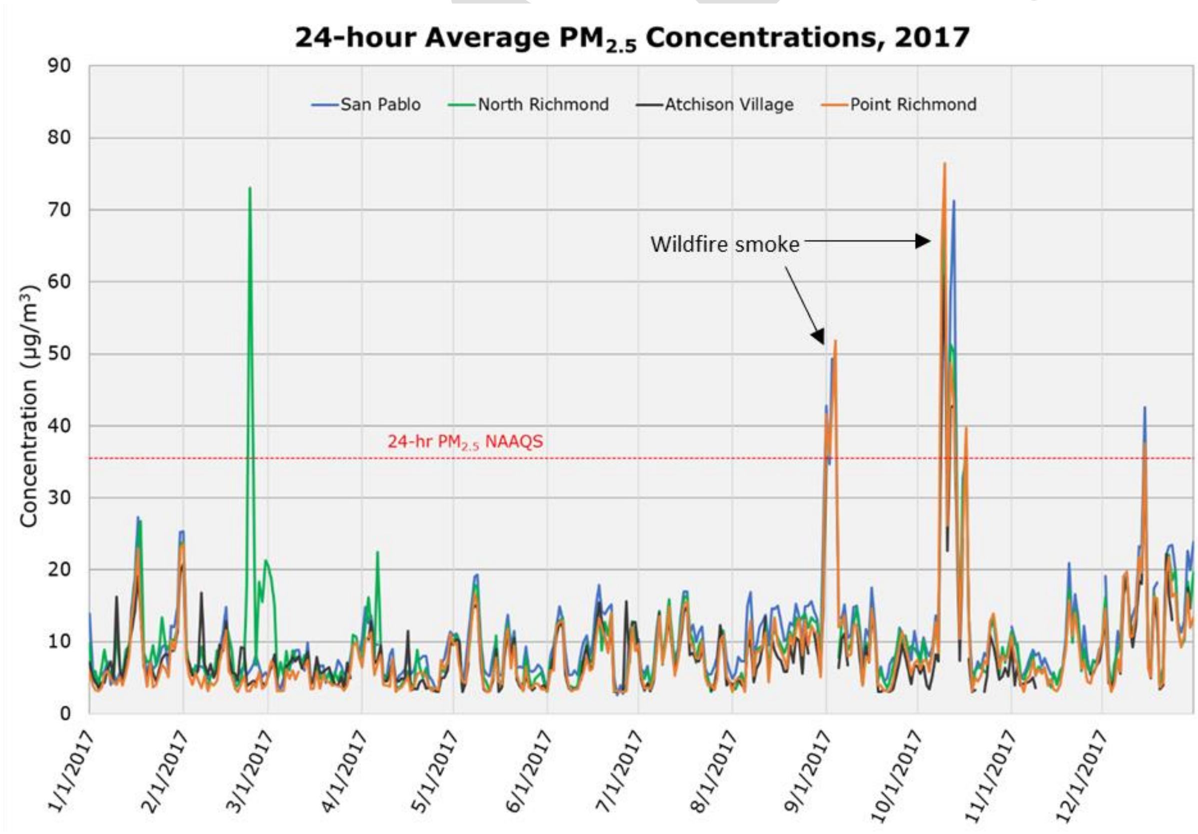


Figure 8. 24-hour Average $PM_{2.5}$ Concentrations in 2017 from Stations in the Richmond-San Pablo Area.

[19] EPA has developed two standards for $PM_{2.5}$, one for an annual average basis and one for a 24-hour average basis. More information on EPA's standards can be found at https://www.epa.gov/criteria-air-pollutants/naaqs-table.

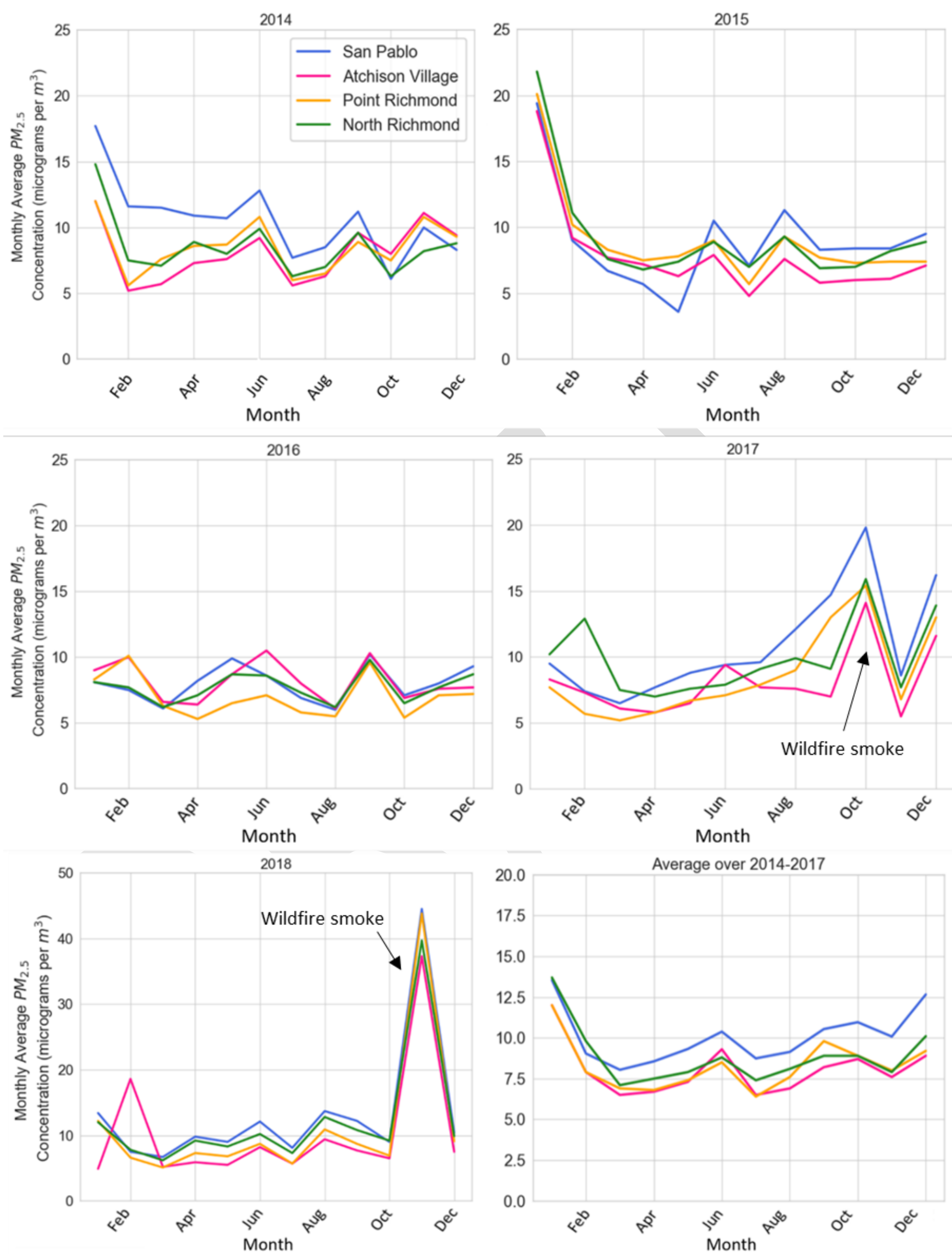


Figure 9. Monthly Average $PM_{2.5}$ Concentrations from Stations in the Richmond-San Pablo Area, 2014-2018. San Pablo is an Air District monitor while the other three are Chevron-Richmond community monitors.

The Air District also monitors for certain air toxics, such as benzene (Figure 10) and toluene (Figure 11), on a 1-in-12 day schedule at its San Pablo and Richmond stations. Overall, concentrations of these air toxics have been similar at both stations and do not show an evident upward or downward trend over the 11-year period shown, with occasional higher concentrations and with some seasonal variability evident in benzene. Wildfire smoke also caused notable increases in benzene concentrations in autumn 2017 and 2018.

Generally, the Air District's air toxics network is designed to capture long-term urban background trends and is not designed for assessing variability in air toxics within the community and on short time scales. The additional air monitoring for $PM_{2.5}$, air toxics, and other pollutants supported under AB 617 is expected to improve our understanding of these local and short-term variations in air quality. The Air District and Steering Committee will continue to analyze data from existing networks and from new monitoring projects to help guide additional air monitoring and emission reduction efforts.

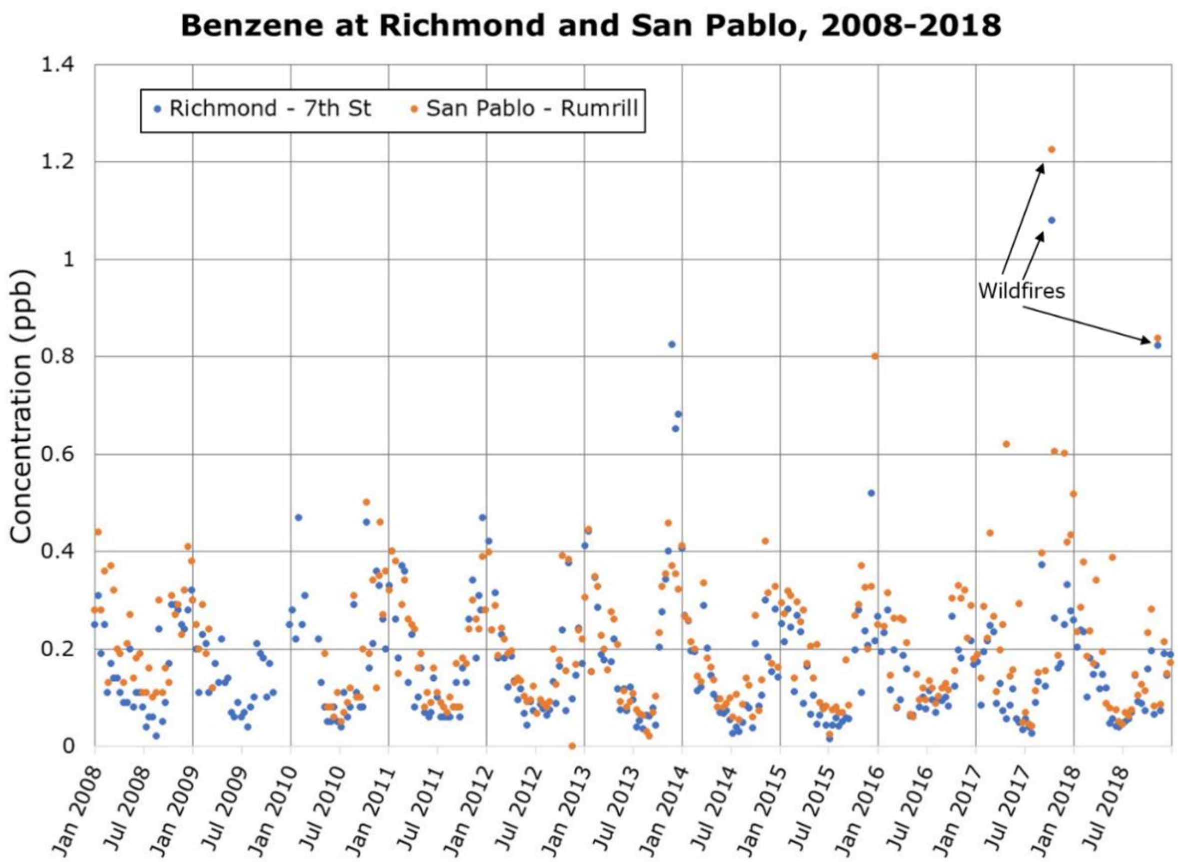


Figure 10. Benzene concentrations at the Air District's San Pablo and Richmond stations, 2008-2018. The benzene measurements are 24-hour samples taken on a 1-in-12 day schedule.

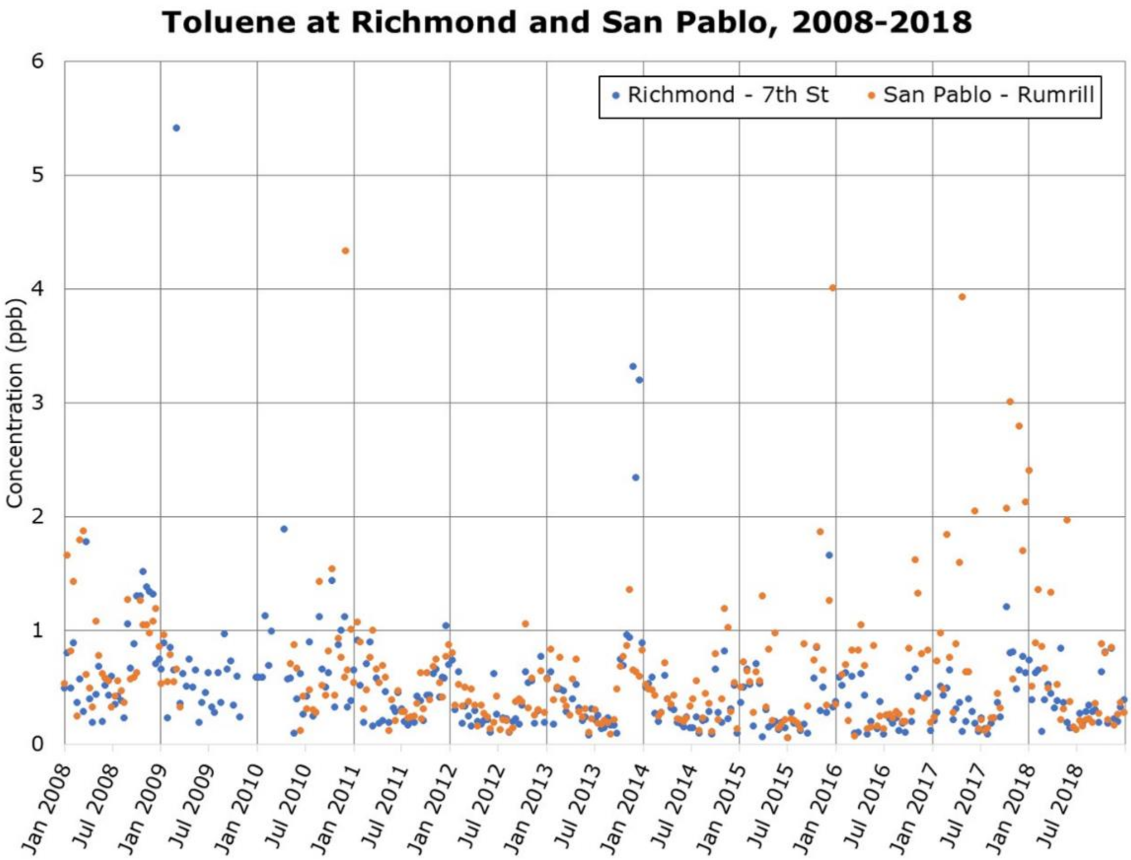


Figure 11. Toluene concentrations at the Air District's San Pablo and Richmond stations, 2008-2018. The toluene measurements are 24-hour samples taken on a 1-in-12 day schedule.

Meteorological data are available at several existing air monitoring stations, as noted in Table 1, and from monitors affiliated with other organizations, such as the National Oceanic and Atmospheric Administration. Data from meteorological monitors across the Richmond-San Pablo area were summarized to illustrate typical wind flows and patterns (Figure 12). With its proximity to San Francisco Bay, there are two general wind patterns in Richmond-San Pablo: onshore winds and offshore winds. The late spring, summer, and early autumn seasons are characterized by onshore winds (in this case, winds from the south or off San Francisco Bay) that are strongest during the afternoon and early evening hours. In late autumn, winter, and early spring, winds typically switch periodically from onshore (from the south) to offshore (from the north), as storm systems move through the Bay Area. At any time of year, winds can vary considerably over time of day and within the Richmond-San Pablo area itself. Existing meteorological data will be an important consideration both for designing new monitoring projects and to provide context to collected air monitoring data and subsequent analyses. In some cases, new air monitoring projects under AB 617 may require collection of meteorological data at additional locations to help inform project-specific monitoring objectives.

Other air quality-related data sets can also be useful for investigating and addressing air quality monitoring needs, both during monitoring plan development and plan implementation. These data sets include air quality modeling data, health screening tools, frequency and location of odor complaints, emissions inventories, locations of sensitive receptors, and the community's own lived experiences.

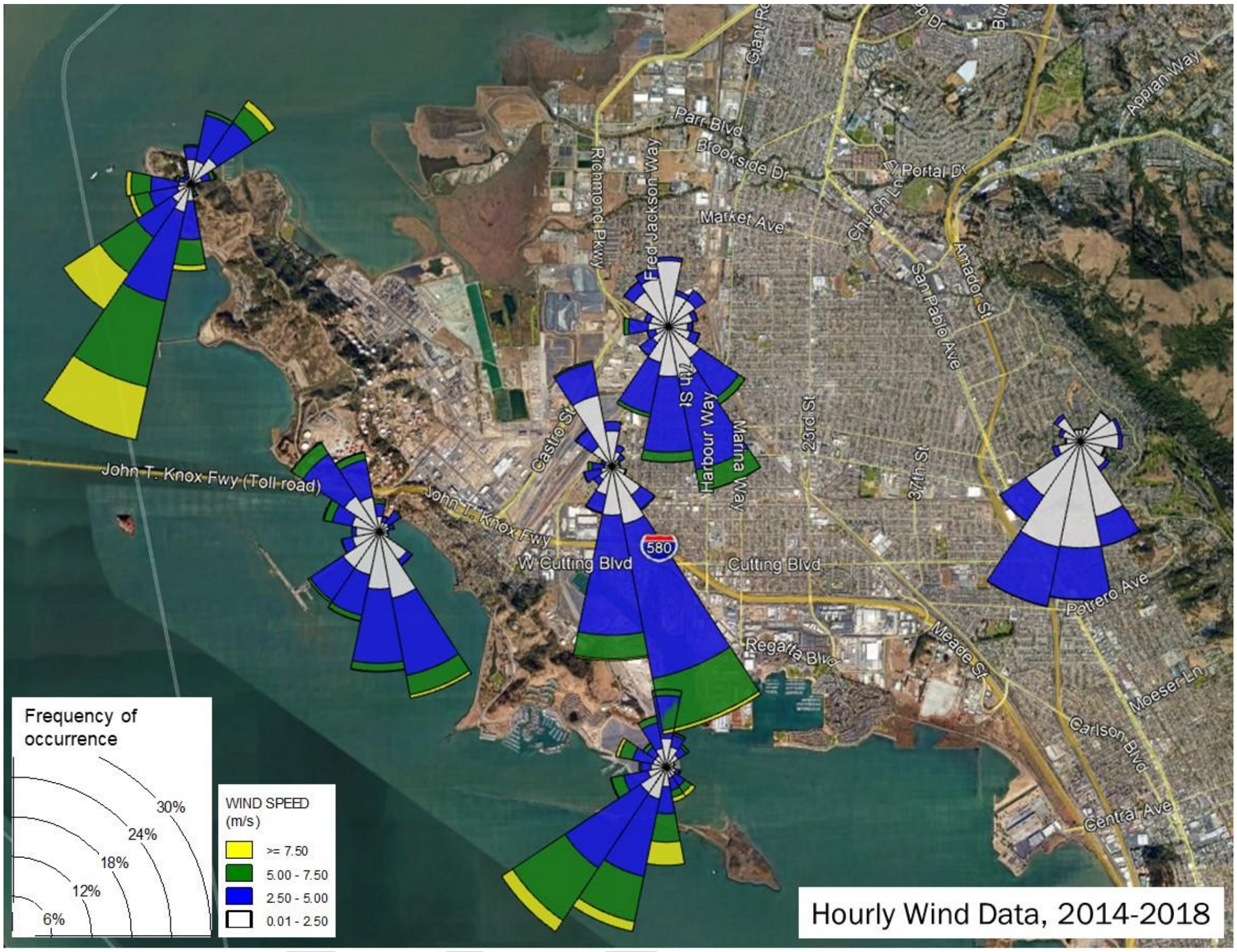


Figure 12. Wind roses for selected meteorological monitor locations in Richmond-San Pablo. Wind roses illustrate the relative frequency of occurence of certain wind directions and speeds. Note: The Air District's meteorological monitoring site at Point San Pablo (upper left) was closed in January 2019. The Air District is working to identify a new location for this site near Point San Pablo.

CHAPTER 4: COMMUNITY-LED PROCESS FOR AIR MONITORING

The Steering Committee spent significant time and effort discussing and identifying air quality concerns in the community and actions they want additional data to support. The Steering Committee began discussing general air quality concerns in Richmond-San Pablo and possible data uses through group mapping activities in Spring 2019. Those discussions included consideration of several data sets, such as locations of emissions sources, sensitive receptors, and existing monitoring locations, and information on health burden from screening tools like CalEnviroScreen and Healthy Places Index. Many of these data sets were made available on an interactive Google map that allowed the Steering Committee to view multiple data sets simultaneously (Figure 13 and Figure 14). From those initial discussions, the Steering Committee determined that air quality screening data for multiple pollutants, and particularly for $PM_{2.5}$, across the entire Richmond-San Pablo area would be helpful to better identify sources of concern and possible future monitoring projects.

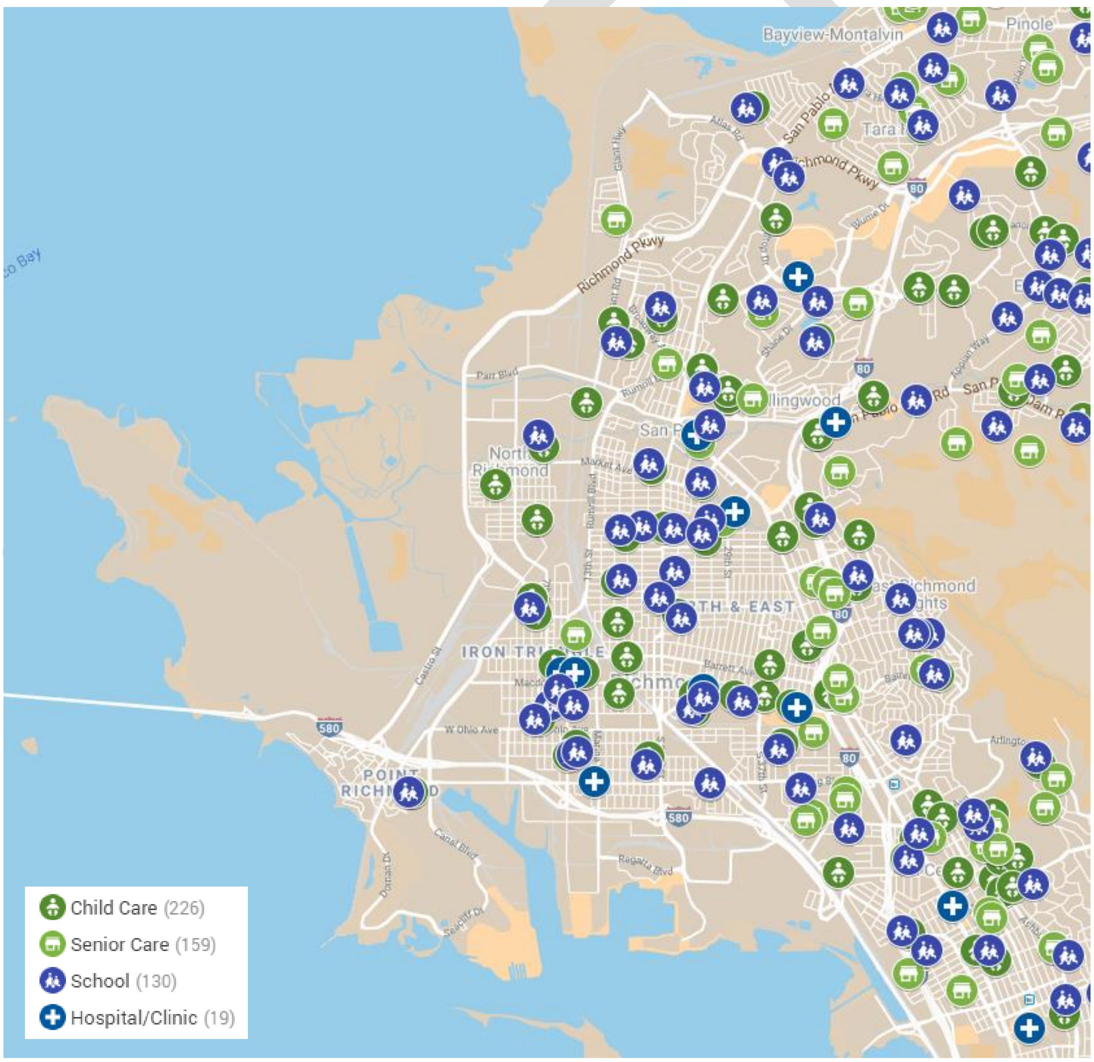


Figure 13. Locations with sensitive receptors (child and senior care facilities, schools, and hospitals) in Richmond-San Pablo, considered by the Steering Committee during monitoring plan development.

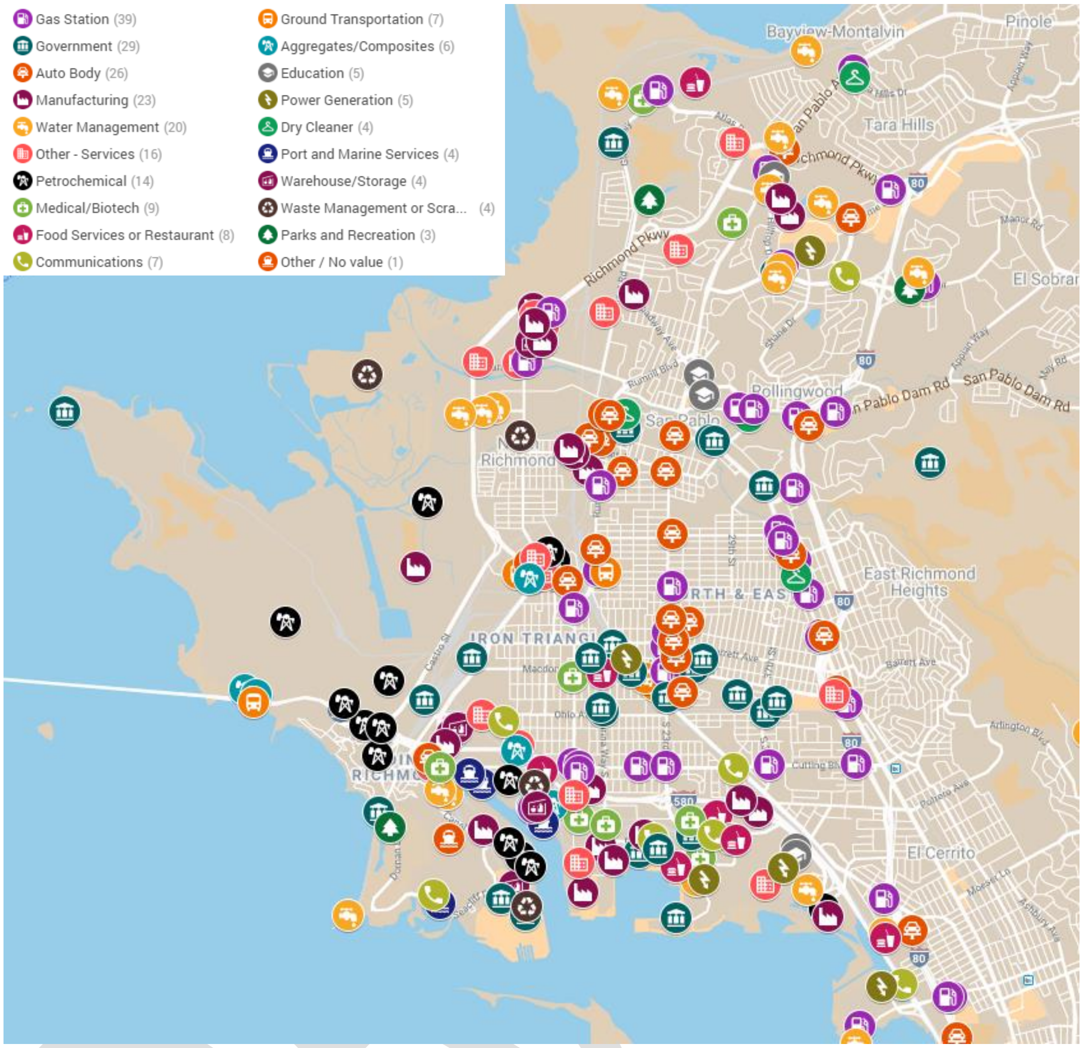
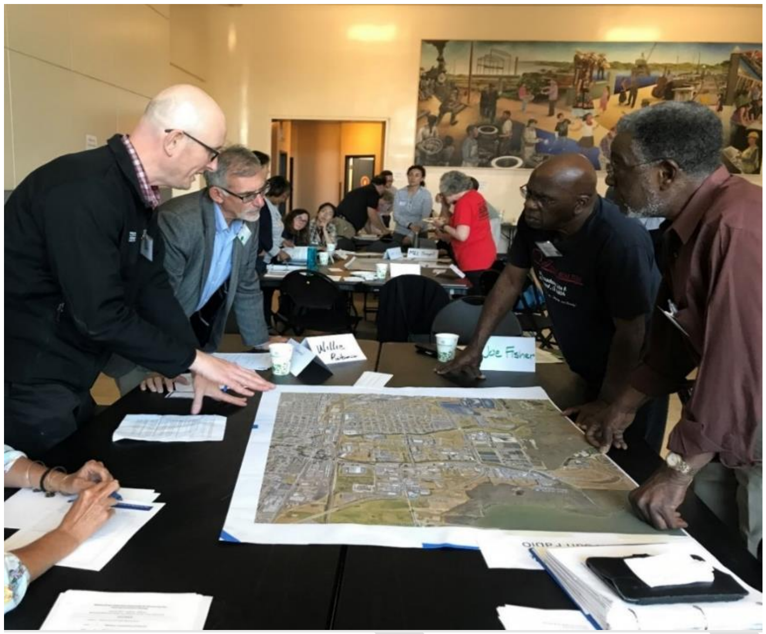


Figure 14. Locations of permitted facilities, categorized by type, in Richmond-San Pablo. This data set was considered by the Steering Committee during monitoring plan development.

Through Summer and Autumn 2019, the Steering Committee discussed and prioritized more specific air quality concerns through additional mapping activities. Given the large geography, these mapping activities were focused on seven subregions to facilitate deeper dives into smaller areas (Figure 15). The Steering Committee was provided maps of each subregion with locations of known pollution sources, existing air monitoring stations, and sensitive receptors, and was asked to provide input on three questions:

1. What, if any, sources of air pollution concern are missing from the area depicted?
2. What potential actions would you like air monitoring data (beyond the initial screening) to support in this area? Actions can include public information for behavior change, identification of areas with elevated pollution levels, or specific quantifiable information to inform new or revised policies or regulations.
3. How should we engage the public in this area so that they can help us choose options for additional air monitoring?



Group discussion on focus areas at a Steering Committee meeting

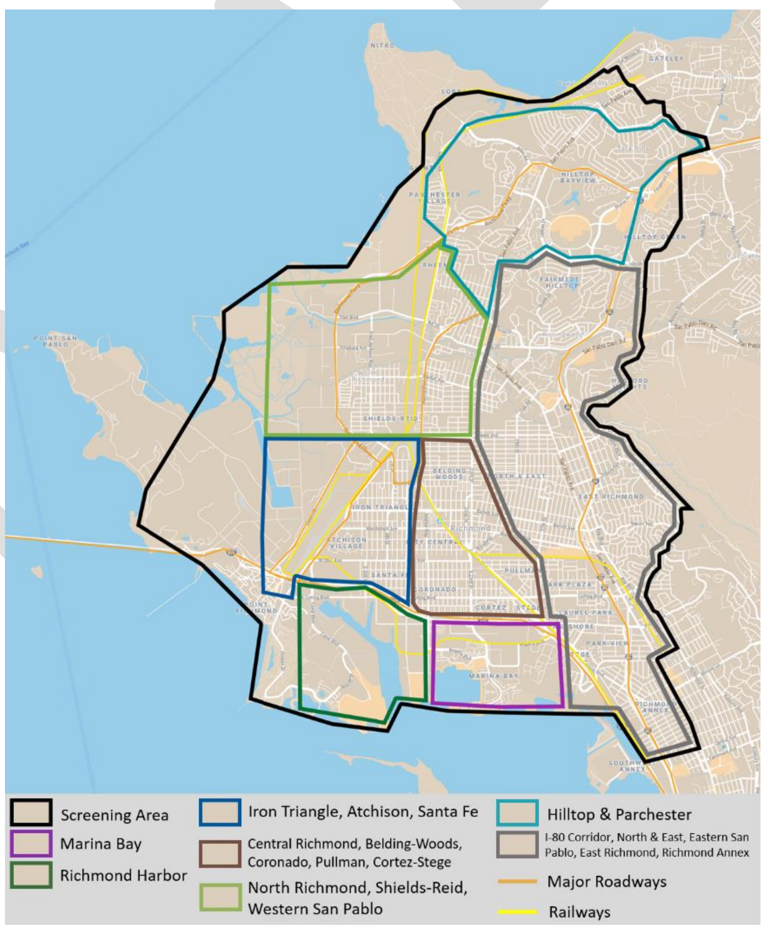


Figure 15. Subregions considered by the Steering Committee to facilitate discussion on pollution sources of concern and desired actions from air monitoring data.

Summary of Community Mapping Discussions

During these collaborative discussions, the Steering Committee and community identified a wide range of air quality concerns across Richmond-San Pablo and potential actions or strategies that new monitoring data could help inform. These concerns and data needs form the foundation of the monitoring plan and are the basis for designing and selecting monitoring projects. The air quality concerns and data needs that resulted from those conversations are summarized below and are organized by common themes that emerged, such as data to support reduction strategies for different source types, or to support other uses including making community-level air quality data available in real-time, informing vulnerable populations about air quality issues, or identifying air pollution hotspots within communities. The concerns and data uses that were prioritized by the Steering Committee at its November 2019 meeting and through community input at a community summit in November 2019 are highlighted in blue.

Data to support reduction strategies for mobile and off-road sources

- **Marine vessels/operations** (harbor craft, ferries, ocean-going vessels)
    - How do marine operations in Richmond inner harbor (including Levin Terminal) affect local air quality?
    - Which marine vessels contribute most to air pollution in the Richmond Harbor area?
    - How do operations at Chevron long wharf impact nearby air quality?
    - How do marina operations and the SF Bay ferry impact air quality around Marina Bay?
- **Diesel truck traffic**
    - Are trucks following specified truck routes or using local/neighborhood streets?
    - What impact do diesel trucks have on air quality near sensitive receptors (like schools?)
- **Railways, railyards, rail crossings**
    - Can coal dust be detected in the air along railways (like along Carlson Blvd)?
    - What pollutants are produced by rail operations and when are they highest?
    - Where are how frequent are traffic backups at at-grade railroad crossings? What impact do those backups have on local air pollution?
- **Busy or congested surface streets**
    - How does commuting along surface streets to avoid freeway or Richmond Parkway traffic affect neighborhood air quality? Some specific streets include Fred Jackson Way and Market Avenue in North Richmond, Harbour Way, Pennsylvania Ave, Rheem Ave, Barrett Ave, Macdonald Ave, 13th Street, 23rd Street, San Pablo Ave, Solano Ave, and Arlington Blvd.
    - What are pollution levels along busy roadways adjacent to schools?
- **Off-road diesel sources** (like generators and construction equipment)
    - How do housing construction projects around Marina Bay and Point Richmond impact neighborhood air quality? Are there other locations with significant construction impacts?
    - What impact do diesel generators have on air quality and where? How often are they in use?
- **Freeways**
    - What is air quality like in neighborhoods along I-80 and I-580 compared to neighborhoods farther away from the freeways?
    - What happens to pollution levels when traffic backs up onto surface streets, and where are the largest impacts?

<u>Data to support reduction strategies for stationary sources</u>

- **Large permitted sources** (like Chevron, Chemtrade, petroleum product storage, coal terminal, metal scrap or welding, water treatment, landfill, cement plant)
    - What are air pollution levels (PM and air toxics) in neighborhoods adjacent to Chevron? How do refinery sources/operations (including non-stack sources such as tank storage, bioreactor, current or former refinery ponds) contribute to air pollution?
    - Validate emissions estimates on permitted sources and identify new sources that may need permits.
    - What is the impact of coal terminal and related operations on local air quality? Some identified concerns include coal piles at the terminal, unloading and loading operations, and trains carrying coal (such as along Carlson Blvd.)
    - Do the metal scrap facilities near Brookside impact the nearby youth center or other nearby neighborhoods?
    - What is the impact of emissions from the wastewater treatment plant in areas nearby where people spend time? How often is it an issue and what is causing the odor?
- **Warehouses and truck-related businesses**
    - What impact do delivery/distribution centers (like Amazon, Whole Foods, Blue Apron, UPS, USPS) have on local air quality, particularly where they are concentrated in North Richmond, Marina Bay and north of Hilltop?
    - What kinds of trucks (and how many) do businesses use? What routes do they take?
- **Sources of fugitive particulate matter and dust or air toxics**
    - What is the impact of rock crushing operations on local air quality, particularly near facilities near North Richmond (like at 7th Street and Vernon Ave.) and at the Richmond port?
    - What is the impact of dust from empty or abandoned lots on air quality, such as near the BART railyard or along other rail lines or roads on land owned by Caltrans?
    - Are there air quality impacts (PM or air toxics) from historic sources or contaminated land areas?
- **Common small businesses**
    - What impact do certain small businesses have on neighborhood air quality:
        - Auto body shops (particularly the cluster along 23rd Street)
        - Restaurants/food/beverage (like barbecues, broilers, bakeries, breweries)
        - Dry cleaners
        - Gas stations
- **Future sources**
    - How and where do we expect construction projects (such as new housing developments or at the Richmond-San Rafael Bridge toll plaza) impact neighborhood air quality?
    - Are there expected neighborhood impacts from upcoming new large facilities, such as the planned PowerPlant cannabis processing facility or new warehouses in the vicinity of Brookside Drive?

Data to support other uses

- **Real-time and accessible information**
    - Website or app with real-time neighborhood-level data
    - Alert/notification system when real-time pollution levels rise to a certain level
    - Provide data of all types that are easy to interpret to make health-based decisions
    - What/how much pollution is the public exposed to at recreational areas, such as along the Bay Trail, at Point Pinole, Miller/Knox Regional Shoreline, or at other parks and playgrounds?
- **Locate and identify pollution hotspots**
    - Where are pollution levels (PM and air toxics) unusually high, especially near sensitive receptors or where people spend time?
    - What pollution sources contribute to unusually high pollution areas? When (days of week or times of day) do these hotspots occur?
    - How does pollution (PM and air toxics) vary overall from neighborhood to neighborhood?
- **Track air quality trends over time**
    - Are pollution levels changing? If so, what is causing those changes?
    - How do we best track progress from emissions and exposure reduction efforts?
- **Odor Identification**
    - What sources are odors coming from, particularly in vicinity of Richmond Harbor, Marina Bay and North Richmond?
    - What pollutants/compounds are associated with odors? Are there any present that have known health risks?
    - What pollutants and health risks are associated with odors or other emissions from restaurants?
- **Collect and share air quality information for vulnerable populations**
    - What/how much pollution are children exposed to at or near schools?
    - Data to alert schools to make decisions on outdoor activities, events and filtration.
    - Are there areas with elevated pollution levels where vulnerable people spend time (like senior centers, day care centers, schools, or medical facilities)?

The air quality concerns identified by the Steering Committee were wide-ranging across geographies and categories of pollution sources, highlighting the need for a comprehensive approach to air monitoring. Once implemented, new insights generated by additional monitoring will inform strategies for reducing local emissions and exposure that vary significantly in space and time. Exposure is influenced by many factors, including background air composition, emissions from nearby natural and man-made sources, transport of air pollution into the community, meteorology, atmospheric chemical reactions, and topography. Robust, quantitative data needed to improve our understanding about the contributing sources requires a combination of different types and modes of monitoring.

Overall Monitoring Approach

To help address these challenges and inform community-identified air quality concerns, the overall strategy for monitoring in the Richmond-San Pablo is to:

1) Define community air quality concerns or desired actions that may need additional or different types of monitoring data.
2) Exploratory measurements throughout the Richmond-San Pablo study area to identify localized areas with disproportionate levels of air pollution. Initial monitoring projects selected to conduct these exploratory measurements are introduced in Chapter 5.
3) Use (1) community-identified air quality concerns and data needs and (2) information from existing monitoring or the initial monitoring projects to prioritize and select additional monitoring projects. Additional monitoring projects are discussed in Chapter 6.
4) Use analysis of new monitoring data and other types of existing data and information to:
    a. refer identified pollution sources to the Air District or other responsible agencies for immediate action, such as enforcement or incentive funding, and
    b. develop list of facilities or sources, and potential strategies for reducing emissions and exposure for an eventual Community Emissions Reduction Plan or other initiatives.

It is expected that several modes of air monitoring will be required to produce actionable data that can inform robust emissions and exposure reduction strategies since different monitoring modes have different strengths and limitations. Table 2 provides some general considerations for monitoring modes and possible applications in relation to air quality concerns identified by the Steering Committee. A monitoring mode or project may provide data that can help inform more than one concern or data need. For any type of air monitoring, data quality can be affected by instrumentation, calibration, siting, and quality assurance or quality control measures.

Exploratory monitoring methods using mobile sensors or dense networks of stationary sensors can span large areas and either capture snapshots in time or extend over a long duration, respectively. While these modes may not be able to measure every pollutant of interest or be as quantifiable or robust as other approaches, they are the best at quickly finding localized variations in air quality. These modes are well-suited to provide data that can inform several of the air quality concerns identified by the Steering Committee, such as providing real-time air quality conditions across Richmond-San Pablo, neighborhood-to-neighborhood.

Special studies using advanced techniques that measure more specifics about the air pollution, such as the chemical make-up of PM or air toxics, can help isolate and quantify the contribution from various sources and can be deployed on mobile or stationary platforms depending on the instruments used. While they cannot be deployed in as many places for long periods of time as other monitoring modes, information collected from screening and other existing air quality and emissions information can help target the right areas or times to focus on to support the desired action.

Table 2. Overview of air monitoring modes, their features and limitations, and possible applications in relation to Steering Committee air quality concerns.

Monitoring Mode	Features	Limitations	Potential Applications
Saturation: dense sensor network	• Stationary measurements • Good spatial and temporal coverage • Can be easier to use and deploy • Results help direct resources for more extensive monitoring	• Limited pollutants • Requires significant resources for upkeep depending on network density and instrumentation used, and for data management and visualization • Potentially lower and more uncertain data quality	• Provide real-time air quality data to the public • Compare air quality from neighborhood to neighborhood • Identify and interpret pollution hotspots for certain pollutants • Can inform people's exposure if sensors are located in places where people spend time outdoors • Help evaluate short-term patterns in pollutant levels (such as time of day, weekday/weekend patterns)
Mobile: making measurements while in motion	• Very good spatial coverage • Multiple passes can reveal persistent hot spots • Results help direct resources for longer term or more extensive monitoring	• Many passes are required to build confidence in results • Sampling not designed to capture rare or intermittent emissions • Not designed to provide information on short- or long-term pollution trends • Generates vast amounts of data requiring complex analysis • Instruments and operation may be costly • Some instrumentation, such as sensors, may potentially have lower and more uncertain data quality	• Compare air quality from neighborhood to neighborhood • Identify and interpret pollution hotspots for certain pollutants • Identify areas with elevated pollution levels in relation to where vulnerable populations spend time • Identify sources of odors and associated pollutants
Portable: stationary for short periods (hours to days)	• Portable instrumentation with minimal site preparation • Wider range of instruments and pollutants possible • Medium to high data quality	• Short monitoring periods • May need access to power • Instruments (and pollutants) are limited to those that are relatively easy to transport and deploy	• Characterize impact from specific sources or operations, whether they be permitted stationary sources, mobile sources like railyards, marinas, or freeways, or emission impacts that happen infrequently • Investigate temporal patterns of hotspots identified via mobile monitoring as needed • Identify candidate locations for short- or long-term monitoring • Colocation and validation of instruments • Identify sources of odors and associated pollutants
Short-term: stationary for moderate periods (weeks to months)	• Widest range of instruments and pollutants possible, yielding more specific data • High data quality	• Moving may be difficult depending on size • Access to reliable power at a secure location makes siting difficult • Low spatial coverage • May be costly	• Characterize impact from specific sources or operations, whether they be permitted stationary sources, mobile sources like railyards, marinas, or freeways, or intermittent sources like construction projects • Investigate temporal patterns of hotspots identified via mobile monitoring as needed • Capture and evaluate short-term patterns in pollutant levels near pollution sources or vulnerable populations to inform emissions and exposure reduction efforts
Long-term: stationary for long periods (years)	• Widest range of instruments and pollutants possible, yielding more specific data • High data quality	• Difficult and costly to move • Needs reliable power, secure location and long-term permitting and/or lease • No spatial coverage • Costly to build and maintain, can take years to establish	• Track long-term pollutant trends (seasonal, annual, multi-annual) • Evaluate effectiveness of emission reductions efforts over time

CHAPTER 5: INITIAL MONITORING PROJECTS

The Steering Committee began discussing general air quality concerns and possible data uses through group mapping activities in Spring 2019. From those discussions, the Steering Committee determined that exploratory measurements of $PM_{2.5}$, NO_2, and other commonly emitted pollutants across the entire Richmond-San Pablo area would help to better identify sources of concern and direct resources for more-complex monitoring efforts more efficiently. In June 2019, the Steering Committee selected three such air monitoring projects led by Aclima, Groundwork Richmond, and Physicians, Scientists, and Engineers for Healthy Energy (PSE) in partnership with the Asian Pacific Environmental Network (APEN) (Table 3). For the pollutants that can be measured relatively well using the instrumentation and methodology specific to each of these projects, data resulting from these projects may help inform several objectives including improving the understanding of pollution levels between neighborhoods, identifying air pollution hot spots, assessing exposure where vulnerable people spend time, and providing real-time data to the public. This chapter contains an overview of these three initial monitoring projects. Technical details for each project are in Appendix C for Aclima, Appendix D for Groundwork Richmond, and Appendix E for PSE/APEN.

Table 3. Initial monitoring efforts selected by the Steering Committee.

Organization[20]	Monitoring Type	Pollutants Measured
Aclima	Mobile: block-by-block screening	$PM_{2.5}$, NO_2, O_3, CO, CO_2
Groundwork Richmond	Saturation: network of 50 Clarity sensors	$PM_{2.5}$, NO_2
PSE/APEN	Saturation: network of 50+ Aeroqual sensors	50 monitors for $PM_{2.5}$, NO_2, O_3
		5 monitors for $PM_{2.5}$, VOC, CO

Aclima Mobile Monitoring

In July 2019 the Air District contracted with Aclima to conduct region-wide baseline mapping of concentrations of O_3, NO_x, PM, CO, and CO_2. At the request of the Steering Committee, the Air District funded an additional task to have Aclima begin a three-month long intensive monitoring effort across the entire Richmond-San Pablo study area (Figure 16). For this intensive effort, Aclima used their mobile platform equipped with a proprietary sensor node to make block-by-block air quality measurements along all publicly accessible roadways. Since the measurements are made across all days of the week and times of day, the resulting air quality maps are representative of many circumstances that can affect air pollution levels in addition to depicting average pollution levels over the three-month period. These maps may indicate areas where pollutants are higher than others on average, showing persistent air quality disparities as well as locations to direct further air monitoring investigations.

[20] Additional information about these projects are found in Appendices C, D, and E, and online at the following sites:

Aclima: https://insights.aclima.io/
Groundwork Richmond: http://www.groundworkrichmond.org/air-rangers.html
PSE/APEN: https://www.psehealthyenergy.org/our-work/richmond/

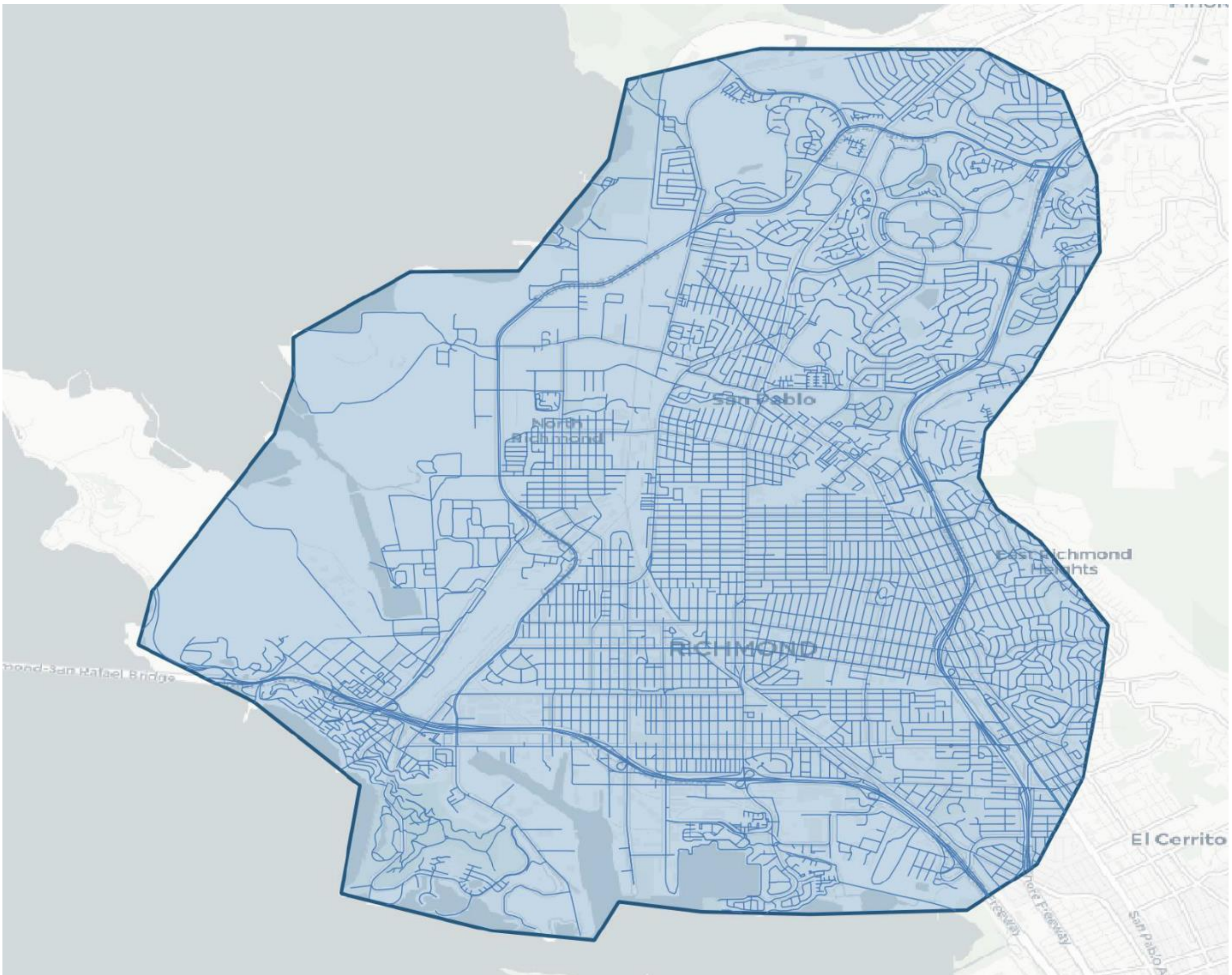


Figure 16. Map of study area for Aclima's three-month mobile monitoring project in Richmond-San Pablo.

Aclima's intensive monitoring in Richmond-San Pablo ran from August through October 2019. In February 2020, Aclima released its Public Insights website for Richmond-San Pablo. Using Public Insights, the community can view maps of average pollutant concentrations over the three-month study period, see information on notable locations where higher or lower levels of pollution were measured, and enter street address to see what pollutant concentrations were like at that location. Aclima may add data from other monitoring projects to its Public Insights website in the future.

The quality of data collected via the Aclima study is assured and maintained through automated data processing and periodic comparison and calibration of sensor nodes to standards. More technical details on Aclima's intensive monitoring effort in Richmond-San Pablo are found in Appendix C. Aclima's region-wide baseline pollution mapping is ongoing and, when available, will provide additional hyperlocal data across the Bay Area, including Richmond-San Pablo.

CARB Community Air Grants

Groundwork Richmond and PSE/APEN were awarded AB 617 Community Air Grants from CARB in 2019 to establish networks of air quality sensors across the Richmond-San Pablo area. Between the two organizations, approximately 100 sensors are expected to result in a saturation network throughout the study area.

The Steering Committee is working to establish agreements with the Groundwork Richmond and PSE/APEN projects to create a mutually beneficial partnership for the development and implementation of a robust and actionable community air monitoring plan. Included in these agreements will be commitments from the parties to meet regularly, clarify project objectives, identify appropriate data use, and engage in community outreach.

These projects will also include quality assurance and quality control (QA/QC) and data review activities, including as coordination with the Air District on sensor calibration efforts, to help ensure that uncertainties in the data are well understood. Technical details, including QA/QC and data validation methods, are provided in Appendix D for Groundwork Richmond's project and in Appendix E for PSE/APEN's project.

Informing Community Air Quality Concerns

Data from the initial exploratory air monitoring projects are expected to inform and refine additional monitoring projects in the Richmond-San Pablo area. These initial monitoring projects have already collected or are collecting data throughout the Richmond-San Pablo area and are suitable approaches to provide data that can help address some of the air quality concerns identified by the Steering Committee.

Hyperlocal air quality data that Aclima collected is expected to help inform concerns related to pollution from mobile sources (including freeways and high-traffic areas) and from stationary sources that are consistent or frequent emitters, persistent hotspots for the measured pollutants, comparing air quality across neighborhoods, and characterizing the average air quality near locations with vulnerable populations. Groundwork Richmond is already providing real-time air quality data accessible online. Having access to real-time air quality information was identified by the community as a high-priority data need, as this data can help persons make decisions about reducing their exposure. In addition, with sensors located in different neighborhoods throughout the area, data collected by the Groundwork Richmond and PSE sensor networks may be used to compare pollution levels from one neighborhood to another, examine trends in air quality over time, and help characterize areawide pollution sources impacting the community. In cases where sensors are located near particular sources or locations, those data may also help inform concerns related to mobile sources, freeways, high-traffic streets, stationary sources that are consistent or frequent emitters, and air quality near vulnerable populations.

CHAPTER 6: ADDITIONAL MONITORING PROJECTS

As described in Chapter 3, the Steering Committee identified a wide range of air quality concerns and data needs across Richmond-San Pablo. The initial monitoring projects are expected to inform some of the above concerns, such as providing real-time data for the public or comparing levels of certain pollutants from one neighborhood to another. Other concerns, like identifying hot spots of air toxics or quantifying the impact from specific facilities, will need data from more-specialized air monitoring projects. To help guide development of additional monitoring projects, the Steering Committee began prioritizing these air quality concerns and data needs. The public also provided input on this process at a Community Summit held in November 2019.

Having access to real-time, understandable air quality data; identifying pollution hotspots, particularly as they relate to locations with vulnerable populations; and supporting emissions and exposure reduction efforts on traffic-related issues like congestion and diesel PM, large and small permitted sources and sources of odors, and rail transport (particularly related to coal and petroleum coke) were identified as high-priority concerns and reasons for collecting additional air quality data. The Air District developed options for additional monitoring projects that could provide data to help inform those concerns and data needs that the initial monitoring projects were not designed to produce data for. The proposed additional projects were:

1. $PM_{2.5}$ Hotspots from Traffic
2. PM Impacts from Coal and Petroleum Coke Operations
3. Identify Air Toxics Hotspots

Descriptions of each project option are provided in Appendix F. These descriptions include the purpose(s) of the monitoring project, datasets to be collected, monitoring modes and approaches to be used, and timelines for each phase of the project.

The Steering Committee reviewed and considered these project descriptions and additional materials and presentations prepared by the Air District before making a decision on where the Air District should first direct its monitoring resources in Richmond-San Pablo. At its January 2020 meeting, the Steering Committee participated in small-group activities to rank these three projects by their urgency, how well the projects meet high-priority air quality concerns, and how well the projects are understood. The Steering Committee found that, overall, the "$PM_{2.5}$ Hotspots from Traffic" and "Identify Air Toxics Hotspots" options were more urgent and met more high-priority air quality concerns, and that more information was needed on all three project options before selecting one to move forward with.

For the February 2020 Steering Committee meeting, the Air District prepared additional materials to help answer key questions that the Steering Committee had on the additional monitoring project options. After discussion, the Steering Committee voted to move forward with the air toxics monitoring project, focused on measurements of volatile organic compounds (VOCs) using the Air District's air monitoring van. Additional monitoring projects beyond the selected option are also possible, pending findings from existing/planned projects and Air District resources. In addition, while the selected project design will be focused on air toxics, the air monitoring van will be collecting some PM-related data that may also be later analyzed to provide information on PM levels and contributing sources in the air toxics study area.

Air Toxics Monitoring Project

In spring of 2020, the Air District began more-detailed planning for the air toxics monitoring project selected by the Steering Committee, focusing on establishing a study area and identifying target compounds. The Richmond-San Pablo area is expansive and contains a multitude of diverse and complex emissions sources, and we cannot realistically understand and characterize impacts from all of these sources across the entire area as part of this air toxics monitoring project. The Air District used data sets and information sources like emissions inventories, odor complaint information, existing measurement data, and Steering Committee priorities and lived experiences, to identify an area that captured most of the known or potential sources of air toxics and some nearby neighborhoods in which to begin exploratory measurements for gas air toxics. This area is bounded roughly by Richmond Parkway on the west and north, 23rd Street on the east, and Richmond Harbor on the south. This area contains many different types of pollution sources of various sizes that emit different combinations of air toxic pollutants, including many of the specific sources of concern previously identified by the Steering Committee, such as petroleum refining, storage, and transport operations, waste management and water treatment facilities, small permitted sources like auto body shops and gas stations, railways, and the I-580 freeway. In addition, this corridor includes several neighborhoods, providing an opportunity to collect air toxics measurements in residential and commercial areas where people live and work.

A primary objective of this air toxics project is to use different types of measurements, along existing information and data on air toxics, to find persistent, hard-to-characterize or hard-to-quantify emissions around known facilities and throughout nearby neighborhoods. This project is being designed to meet this objective by selecting appropriate instruments and approaches to capture, to the extent possible, a range of time periods and meteorological conditions. The Air District will first conduct the exploratory air toxic measurements, primarily for VOCs, using its new air monitoring van (Figure 17). VOCs represent a large group of organic compounds that are emitted by a wide variety of sources. Instrumentation onboard the air monitoring van, specifically the proton transfer reaction mass spectrometer (PTR-MS), can measure concentrations of many VOCs in near-real-time at a hyperlocal level. Across the study area, this approach can provide information about the general spatial variations or locate plumes of common gas-phase air toxics like benzene, toluene, ethylbenzene, and toluene (BTEX), compounds produced by a wide range of sources including refinery and related operations and other combustion sources like motor vehicles. Other compounds that are typically produced by more-specific sources can also be targeted while monitoring near those sources.

The screening measurements acquired from the air monitoring van will be used to locate areas where air toxics concentrations are much higher than surrounding areas (hotspots). When these areas are located, additional measurements may be collected to better understand the frequency, duration, and possible source(s) of those higher concentrations. Measurements from the air monitoring van will generally provide a snapshot in time of pollutant concentrations. In some cases, other monitoring capabilities such as portable or fixed-site short-term monitors may be utilized to help capture daily variations or patterns in pollutant concentrations that can better inform the contributing source(s) of the problem.

This project is not designed or expected to locate and characterize every possible air toxics problem within the study area, as no single monitoring project can realistically find and provide information on all air quality problems. This project is intended to locate and understand large impacts so that actions can be taken to mitigate those impacts as quickly as possible. As with any field measurement project, possible challenges and limitations must also be considered. There are many potential overlapping sources of air toxics in the Richmond-San Pablo area, which may complicate identifying individual sources or quantifying the contribution of one specific source among many. Occurrences of unusually high air toxics levels may be short in duration and/or frequency, making them more difficult to characterize and trace. In addition, weather conditions, such as wind direction and precipitation, may not be conducive for short-term studies, possibly requiring additional time to collect sufficient measurement data. Other logistical factors must also be considered, such as access to possible monitoring locations, particularly should portable or short-term stationary measurements be needed.

Figure 17. The Air District's air monitoring van.

Pending shelter-in-place restrictions due to COVID-19, mobile monitoring for this project is expected to begin in Summer 2020. Updates on project status, data, and findings will be shared with the public through routine updates at Steering Committee meetings and through the Air District's Open Air Forum website. More-detailed technical information on the air monitoring project is provided in Appendix G.

Data from the Air District's air toxics monitoring project are expected to help inform some additional community air quality concerns beyond the data from the initial projects, including:

- Identifying and understanding where levels of certain gaseous air toxics are unusually high and determining if those hotspots are near locations with vulnerable populations
- Evaluating gaseous air toxics levels near facilities identified and prioritized by the Steering Committee, such as waste and water management facilities, metal facilities, refinery and petroleum operations, or common small businesses like auto body shops, restaurants, dry cleaners, and gas stations
- Identifying sources and pollutants associated with odors

Data collected from this project may also be compared to air toxics data collected at fixed-site stations operated by the Air District or the Richmond-Chevron community monitoring stations, and from the Chevron fenceline monitoring required under Air District Rule 12-15. These data are expected to help inform emissions and exposure reduction strategies and other Air District enforcement and rule development efforts.

CHAPTER 7: COMMUNICATION PLAN

This section outlines the communication plan for how the Air District and other organizations will disseminate data, work products and other critical information with the Steering Committee and the public. The Co-Lead Team and Air District recognize the importance of communicating the development of the Monitoring Plan and resulting data, updates, and finding, to ensure that these efforts are useful to and understood by the community and stakeholders. The Air District is the main point of contact regarding the monitoring plan and its implementation. Questions or comments regarding the plan can be sent to AB617info@baaqmd.gov, and from there the Air District will relay messages to community partners and individual monitoring project leads as needed.

Monitoring Plan Outreach and Communication

The co-leads drafted an outline for the Monitoring Plan and shared it with the Steering Committee in July 2019 for feedback. As the Monitoring Plan development process has progressed, Air District staff have populated the outline and incorporated comments from the co-leads and CARB, resulting in an initial draft Monitoring Plan in December 2019. Comments received from the Steering Committee and CARB on the initial draft were incorporated into this final draft. Subsequent Steering Committee decisions and updated technical information on the monitoring projects were also added to this final draft. As the oversight agency for AB 617 programs, CARB will review and provide comments on the Monitoring Plan.

Data from all monitoring projects selected by the Steering Committee will be made available to the public as is mandated in AB 617. Representatives from each of the three initial monitoring projects are in regular contact with the Co-Lead Team and provide regular updates on their projects to the Steering Committee. This plan for routine updates is expected to continue at least through 2020. Monitoring data collected by Groundwork Richmond are available in real-time on the City of Richmond's Transparent Richmond website. Aclima released its public-facing Insights web portal in February 2020 in coordination with the co-leads and the Steering Committee for the data from their project.

Data, analyses, summaries, and reports from monitoring efforts conducted by the Air District as a part of the Monitoring Plan will be made available for download through the Air District's website.

As the Monitoring Plan is completed and the Monitoring Plan Steering Committee stops formally meeting, a Monitoring Outreach Team will partner with the Air District to help shape, review, and present updates on monitoring projects and engage with the community as those updates become available. This team is intended to preserve community partnerships that were established while developing the Monitoring Plan and bring community perspective and insight to updates and information as the Monitoring Plan is implemented. These updates will be shared routinely with members of the Monitoring Plan Steering Committee, Technical Advisory Group, CERP Steering Committee, and the public. Updates will also be posted on the Air District's website and on the Air District's interactive Open Air Forum[21] page. The co-leads recommended that the Monitoring Outreach Team be made up of 5 to 7 members who served on

[21] The Air District's Open Air Forum website: https://www.baaqmd.gov/about-the-air-district/in-your-community/open-air#peak_democracy

the Steering Committee and represented community. The Steering Committee will discuss and decide on this path forward for monitoring implementation at its final meeting in July.

Methods for Communication and Engagement

Information is shared between the Steering Committee, co-leads, Air District, other affiliated organizations, and the public through a variety of methods to promote wide distribution of relevant materials and increase community engagement. Outside of the Steering Committee meetings, most information sharing and interaction between Steering Committee members takes place via email. The co-leads make every effort to have agendas and relevant materials available at least one week ahead of time for Steering Committee meetings. Community summits are announced at least one month in advance via the Air District website, e-blasts, social media and through Steering Committee member outreach with their constituents. Flyers are created to inform the wider community about Steering Committee meetings and community summits. Agendas, meeting summaries and materials are posted regularly on the Air District's Community Health Protection Program and Richmond Area Community Health Protection Program website.[22] Interactive community summits held in February 2019 and November 2019 have encouraged the public to learn about and shape the Monitoring Plan process.

Due to the COVID-19 pandemic and resulting shelter-in-place order, in-person meetings were held online and/or rescheduled starting in March 2020. The Air District used its Open Air Forum page to post Steering Committee meeting materials, such as recorded presentations, slide shows, images, and links, to which the Steering Committee and public can post comments or ask questions. In addition, opportunities for virtual "office hours" were provided over Zoom video conferencing to allow for real-time discussion. The June and July 2020 Steering Committee meetings and all Co-Lead Team meetings are being held over Zoom video conferencing.

The co-leads and Steering Committee are continually exploring new methods to increase engagement and promote the Monitoring Plan process. Over the entire period of the Monitoring Plan development, the Steering Committee members have also spent considerable time sharing specific ways to increase engagement and promote the Plan. The co-leads have been developing additional communication methods and tools, such as press releases and graphic decals for the Air District's air monitoring van. The Steering Committee and the community co-leads have been instrumental in increasing awareness in the Monitoring Plan process through their participation in neighborhood councils and affiliation with youth centers like the RYSE Center and West County First Five.

[22] The Air District's Richmond-San Pablo Area Community Health Protection Program website: http://www.baaqmd.gov/community-health/community-health-protection-program/richmond-area-community-health-protection-program

APPENDIX A: STEERING COMMITTEE MEMBERSHIP AND AFFILIATIONS

Table A1. Membership of the Richmond-San Pablo area Steering Committee as of June 2020. Bold text indicates a member also serves on the co-lead team.

Sector	Affiliation	Member	Alternate
Neighborhood Group or Resident (12 members)	Hilltop Neighborhood	Cesar Zepeda	
	Richmond Heights Neighborhood	**Dr. Naama Raz-Yaseef**	
	Iron Triangle Neighborhood	Oscar Garcia	
	Coronado Neighborhood	Joe Fisher	
	Santa Fe Neighborhood	**Linda Whitmore**	
	Resident Youth	Bryana Gastelum[1]	
	Area Residents (6 members)	Don Lau Annie M. King-Meredith Leydi Maldonado[1] Maria Martínez Resendiz Jessica Range Melvin Siegel	
Community-Based Organization or Nonprofit (11 members)	**First Five**	**Nain Villanueva de Lopez**	
	Idle No More / Rich City Rides	Paul Ehara	
	RYSE Youth Center	**Randy Joseph**	
	Healthy Richmond	Roxanne Carrillo Garza	Pierre Thompson
	NAACP: Richmond Branch	**Willie Robinson**	
	Groundwork Richmond	Matt Holmes	
	West County Toxics Coalition	Dr. Henry Clark	
	Multicultural Institute	Rudy Lara	Mirna Cervantes
	Sunflower Alliance	Janet Johnson	
	PSE Healthy Energy	Boris Lukanov	Lee Ann Hill
	No Coal in Richmond	Julia Walsh	
Education (1 member)	West Contra Costa Unified School District	Marin Trujillo	Martine Blake
Government (5 members)	City of Richmond	Demnlus Johnson	Samantha Carr[2]
	City of San Pablo	Amanda Booth[3]	
	BAAQMD	**Dr. Kate Hoag**	Kristen Law
	CARB	Monique Davis	
	Contra Costa Health Services	Dr. Rohan Radhakrishna	
Industry or Business (6 members)	Chevron	Adam Oliver	Todd Osterberg
	Council of Industries	Katrinka Ruk	Fred Glueck
	Levin Terminal	James Holland	
	Richmond Chamber of Commerce	James Lee	
	Sims Metal	Jill Rodby	
	Anaviv Catering	Arnon Oren	

[1] Two members from the original Steering Committee meeting roster, John Anderson (CBO/non-profit sector) and Siew Weng Lee (resident sector) could not continue their positions on the Steering Committee. The Co-Lead Team considered other applicants and selected and approved Leydi Maldonado (resident sector) and Bryana Gastelum (representing resident youth).

[2] Samantha Carr replaced Adam Lenz as an alternate Steering Committee member for the City of Richmond.

[3] Amanda Booth replaced Elizabeth Dunn as Steering Committee member for the City of San Pablo.

Figure A1. Steering Committee Affiliation by Sector

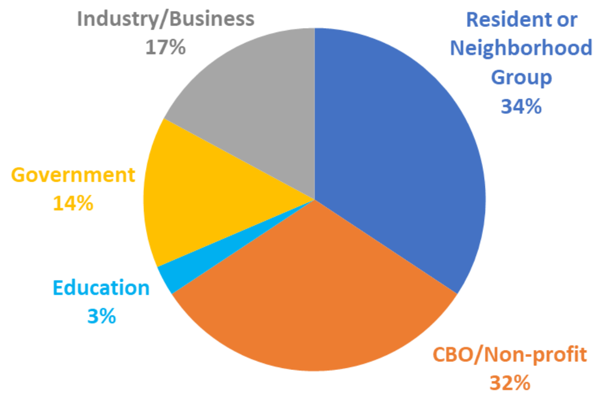


Figure A2. Percentage of Steering Committee representing residents

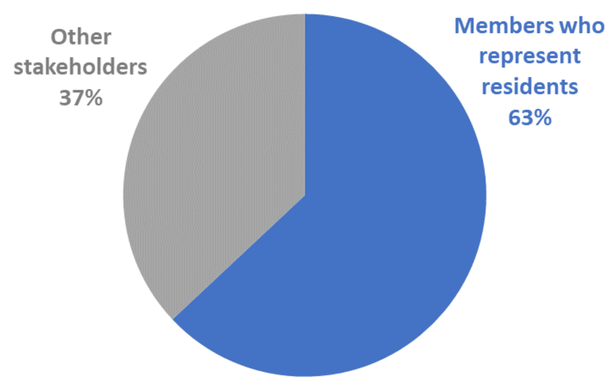


Table A2. Steering Committee meeting dates and number of Steering Committee members in attendance.

Date of Meeting	Steering Committee Attendance	
	Total Attendance	Representing Residents
April 3, 2019	32	19
April 11, 2019	26	15
May 15, 2019	30	17
June 19, 2019	26	17
July 10, 2019	28	16
August 14, 2019	28	18
September 11, 2019	32	20
October 9, 2019	25	15
November 13, 2019	23	16
December 11, 2019	27	18
January 22, 2020	28	18
February 19, 2020	26	17
April 16, 2020	19	12
June 24, 2020		
July 29, 2020		

APPENDIX B: STEERING COMMITTEE CHARTER AND PARTICIPATION AGREEMENT

Richmond Community Air Monitoring Plan

Steering Committee Charter and Participation Agreement

Amended May 17, 2019

1. **Mission Statement**

   Assembly Bill 617 (Garcia, C., Chapter 136, Statutes of 2017) is a State-mandated program that uses a community-based approach to reduce local air pollution in communities around the State that continue to experience disproportionate impacts from air pollution. The Richmond-San Pablo area is the region's first area under the AB 617 program to develop a community air monitoring plan to look for, identify, and understand areas of elevated air pollution exposure in Richmond and San Pablo communities.

   Steering committee members will advise the development of the community air monitoring plan and will act as liaisons between the community stakeholders they represent by disseminating information and transmitting input as appropriate. The key elements of Richmond-San Pablo area Community Air Monitoring Plan (Plan) will need to be completed by early 2019 for monitoring to begin in July 2019.

2. **Steering Committee Objectives**

   The Richmond-San Pablo Community Air Monitoring Plan Steering Committee will serve for the designated purpose outlined in the mission statement. The Committee will: identify the monitoring plan boundary, identify areas of concern for air pollution, potential contributing sources, and vulnerable populations, review existing studies on air quality to provide input towards Plan development. The Steering Committee will disseminate information and consider input from the broader community. The goal is for the monitoring described by the Plan to begin in July 2019. After the monitoring has begun, the Steering Committee co-leads may elect to change the meeting schedule as needed to best support and provide guidance on implementation and develop progress reports.

3. **Membership**

   Steering Committee members will represent people who live in the Richmond-San Pablo area and other interested stakeholders affiliated with various sectors. These sectors can include community-based organizations, youth organizations, non-profits, faith leaders, education, government, health, and business representatives from the Richmond-San Pablo area. To ensure the Plan development remains community-driven, at least half (50%) of the membership must include individuals who represent people or groups of people who live in the Richmond-San Pablo area. The official roster will contain one primary name for each affiliation to be represented on the committee. This person should have the authority to make decisions on behalf of their organization, agency, business, etc. One alternate name can substitute for the primary member if the primary member is unable to attend a meeting. However, only one member from each affiliation will be allowed to deliberate at meetings to reach consensus. The committee meetings are open to the public and additional members may be added to the roster if agreed upon by the community co-leads and the Bay Area Air Quality Management District (Air District) who will serve as co-chairs of the Steering Committee.

4. Roles and Responsibilities

Community Steering Committee Members

Steering committee members will be responsible for assisting Air District and community co-leads in developing the Richmond-San Pablo Community Air Monitoring Plan, in accordance with the California Air Resources Board's Community Air Protection Blueprint[1]. Committee members may be asked to assist in identifying air pollution issues and sources of air pollution in the area, and in reviewing air quality data and local health impact studies to assist in developing the Plan.

Co-Leads

The Steering Committee will be supported by a team of co-leads comprised of one to five community leaders and the Air District. The co-lead team will provide infrastructure support to the Steering Committee and the air monitoring plan development. The community leads will be local to the Richmond-San Pablo Area and can be one trusted organization or a small collective or coalition of individuals.

The co-lead team will be responsible for providing necessary background materials for steering committee members, developing meeting agendas, coordination with the meeting facilitator, and for leading Steering Committee activities. The co-lead team will also be responsible for providing technical support and other relevant technical assessment information to the Steering Committee.

Facilitator

A professional and impartial facilitator will be used for moderating the steering committee meetings and for helping the committee reach consensus on issues.

5. Standard Steering Committee Meeting Procedures

Deliberation and Consensus

Decision-making will not proceed without a quorum of active members. A Quorum will be reached when 51% of active members of the Steering Committee are present and of those present, 51% are individuals who represent people or groups of people who live in the Richmond-San Pablo area. A professional and impartial facilitator(s) will be employed to support the steering committee in the overall organization, order and focus of the meeting, resolve conflicts and help reach consensus to ensure the goals and objectives of this charter are met.

[1] https://ww2.arb.ca.gov/our-work/programs/community-air-protection-program/community-air-protection-blueprint

Achieving full consensus of the steering committee may not always be possible. In the event of an impasse, the co-lead team will be the final decision-makers, carefully weighing the consequences of any decision where there is a lack of consensus. If the co-lead team cannot agree, then the action in question will not proceed. Community Steering Committee members who do not agree with a majority consensus on a decision may submit a minority position statement.

Member Participation

Only one member from each affiliation may participate as part of the steering committee deliberative process in any individual meeting. If the primary member is unable to attend, the designated alternate on the steering committee roster may attend in their absence and deliberate on the primary member's behalf.

If a primary member or their alternate is not able to attend a scheduled meeting, they may submit written comments for consideration on relevant agenda topics to the Committee chair or the co-lead team prior to the scheduled meeting. Written communications may inform, but not substitute, for being physically present during deliberations of the committee. If a primary member or their alternate has not attended three consecutive steering committee meetings, their membership may be revoked as determined by the co-lead team.

Steering committee members are expected to attend a minimum of eight (8) committee meetings (in their entirety) throughout the course of the Plan development and implementation. Community townhall meetings may also be scheduled at the end of plan development and throughout implementation, which members are also expected to attend.

Steering committee members may choose to recuse themselves from decisions at any time. Members **must** *recuse* themselves from decisions where there is a conflict of *interest*. A conflict of interest is any situation in which financial or other business or personal considerations may unduly influence the member's judgment. Steering Committee members who participate in this process are expected to sign the *Richmond-San Pablo Area Steering Committee Participation Agreement* (Page 5 of this Charter) which outlines the expected conduct of all Steering Committee members.

Open Meetings

All meetings are open to the public and will provide a formal opportunity for members of the public to provide their perspective on the development of the Plan. Stakeholder input is welcome and encouraged.

Meeting Schedule and Agendas

Steering committee members are expected to attend monthly meetings. Upon consensus agreement of the committee, meeting schedules and frequency may be adjusted with adequate notice. Agenda topics will be developed by the co-lead team and will include the time, date, duration, location and topics to be discussed. Agendas will be published one week in advance of a scheduled meeting. Individual committee members may request relevant items be added to an agenda at least two weeks prior to the scheduled meeting.

Subcommittees
Members who wish to be further involved may choose to participate in ad-hoc sub-committees. Subcommittees would meet at times deemed appropriate for most of the members and would occur between full steering committee meetings. Sub-committee members will report back their findings and/or recommendations at the next full steering committee.

6. **Amendments**
Amendments to this charter of the Steering Committee of the Richmond-San Pablo Community Air Monitoring Plan require approval by two-thirds of the active voting members of the Steering Committee.

7. **Accessibility/Accommodation**
The steering committee meetings and other outreach events associated with the committee must be held at transit accessible facilities that can accommodate members covered by the Americans with Disabilities Act. Language interpretation services will be provided as needed with a minimum 72-hour (3 days) advance request.

8. **Dissemination of Materials**
Any materials, presentations, documents, correspondence or other written communications generated or disseminated by the committee, or on behalf of the committee or its members, must be approved by the co-lead team prior to release.

9. **Website**

A website will be developed and maintained by the Air District to provide information to the community on the Steering Committee actions and development of the Plan. The community co-leads will help determine content for the website and other forms of communication.

Appendix C: Aclima Mobile Monitoring Project Information

AB 617 Richmond-San Pablo Community Monitoring Plan Elements

Project name: Aclima mobile monitoring in Richmond-San Pablo

Project organizers: Aclima Inc.

Define Air Monitoring Objectives

What are the objectives of this air monitoring project?

As adopted by the Richmond-San Pablo Steering Committee on June 19, 2019, Aclima mapped the Richmond-San Pablo area (defined below), generating 110 million data points, collected over 25,000 miles from August 1 through October 31, 2019. The resulting data provides a block-by-block view of air quality that enables people to see average ambient pollution concentrations over this three month period near their home, school, work, and other places they visit regularly. Mobile air monitoring provides higher spatial resolution than that obtained using stationary measurements. To capture average concentrations at every location, we drive each location many times on different days of the week and at different times of the day. Our research and scientific publications have shown that averaging these repeated measurements creates a representative picture of air pollution block-by-block, resulting in what we refer to as a baseline map.

What will be measured, when and where will it be measured, and why?

Driven with care by drivers from the community, Aclima deployed low-emission cars equipped with cutting-edge mobile air quality sensor devices in Richmond-San Pablo in August – October 2019. As the cars drive each street in the Richmond-San Pablo area, they are continuously collecting and mapping air quality and greenhouse gas levels. The resulting data provides a block-by-block view of air quality throughout Richmond-San Pablo that enables people to see pollution concentrations near their home, school, work, and other places they visit regularly. Insights include measurements of air pollution and climate-changing gases such as carbon dioxide (CO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), nitric oxide (NO), ozone (O_3), and particulate matter ($PM_{2.5}$).

Roles and Responsibilities

What parties are responsible for major aspects or phases of air monitoring? What are the roles of these parties?

Aclima's engineers and scientists lead data collection, QA/QC, data management, and make accessible to the public the findings in software applications. The team includes electrical and mechanical engineers who work with our atmospheric, data, and computer scientists to optimize device and platform design and performance, installing, maintaining, and calibrating the systems. The Aclima fleet of hybrid electric vehicles is powered by drivers hired from local communities. We partner with environmental justice organizations, advocates, and AB 617 steering committees to recruit and hire locally. Jobs are full-time with benefits and provide a path to upskilling and long-term careers in the green economy. Employees that started as drivers are now Aclima fleet managers and data scientists.

What are the training requirements for individuals conducting air monitoring?

Aclima trains its mobile measurement field staff on safe vehicle operations, device operation, route navigation, basic device troubleshooting, and protocols for coordinating with Fleet Operations at headquarters to address any anomalies.

Additional details are discussed in the Standard Operating Procedures section below.

Define Data Quality Objectives

What are the performance and acceptance criteria for collected data?

Data quality objectives are to support the calculation of robust segment aggregates for all publicly available roads in the Richmond-San Pablo area. The Measurement Quality Objectives in the table below are the acceptance criteria that Aclima mobile nodes must meet upon calibration to be installed in a car in our mobile fleet. Data from each mobile node is evaluated during and after collection to determine the validity or correctability of the 1-Hz data. A number of Data Quality Indicators are recorded along with the sensor measurements including multiple in-line temperature, pressure, relative humidity, and flow rate measurements that provide system state diagnostics. Both the individual sensor and the system state data are used to support flags to indicate when the data may not be valid for inclusion in the data set used to create the high spatial resolution aggregates.

What criteria are being used for precision, bias, accuracy, sensitivity, and data completeness?

Acceptance criteria for precision, bias, sensitivity, and completeness are listed in Table 1. Per EPA guidance the term accuracy is not used since it represents both precision and bias measurements. No formal method for sensitivity is specified, therefore, we define it as the standard deviation of the differences vs. reference at the lowest 10th percentile of concentrations experienced during calibrations.

Table 1: Aclima Mobile Node Acceptance Metrics and Values

	Acceptance Metric	Value
CO2	Precision	11 ppm
	Bias	12 ppm
	Sensitivity	4 ppm
	Completeness	95%
CO	Slope	0.75 - 1.25
	r2	>0.8
	Sensitivity	0.050 ppm
	Completeness	95%
NO	Precision	10 ppb
	Bias	10 ppb
	Sensitivity	10 ppb
	Completeness	95%
NO2*	Precision	6 ppb
	Bias	5 ppb
	Sensitivity	0.4 ppb
	Completeness	95%
PM	Slope	0.75 - 1.25
	r2	>0.8
	Sensitivity	1 µg/m3
	Completeness	95%
O3	Precision	3 ppb
	Bias	3 ppb
	Sensitivity	1.3 ppb
	Completeness	95%

* Reported as NO2 +O3

Precision and bias estimates were estimated for CO_2, O_3, NO, and NO_2 based on the methodology used for meeting regulatory quality assurance requirements (U.S. EPA, 2007). Precision and bias are calculated using ambient, on road concentration data measured by reference instruments that are collocated with our sensors in our mobile calibration facility. Precision is expressed as the upper bound (at 90% confidence) of the standard deviation of the measured concentration vs. target concentration. Bias is expressed as the upper bound of the mean absolute error of measured concentrations vs target concentrations.

For the instruments where a direct reference is not available ($PM_{2.5}$ and CO), the acceptance criteria and data quality metrics are defined as sensor-to-sensor uncertainty. In practice, data quality metrics are derived by comparing a single sensor observation to the ensemble mean of other sensors of the same type during on-road collocations. At least 3 additional devices, but typically many more (>10 devices), must be collocated for this ensemble comparison. The performance of our $PM_{2.5}$ and CO sensors compared to Federal Equivalent Methods has been independently evaluated through a separate experiment.

Data Completeness is calculated as the number of verified data points collected relative to the number of data points expected, based on the amount of time the vehicles are driving on the road and the reporting frequency of each instrument. Data can either be missing (not collected because of power or network failure) or invalid (data removed during the data qualification step).

What is the temporal and spatial representativeness of the monitoring?

The collection methodology yields hyperlocal data representative of mean ambient concentration values during the collection period, per road segment. To provide these mean ambient concentration values, Aclima typically gathers at least 20 measurements for the collection period of three months, per road segment. Driving assignments are randomized in the region to provide reasonably distributed measurements across day-of-week and time-of-day over the collection period, 24 hours a day, weekdays and weekends, to minimize bias associated with temporally variable concentrations. Upon completion of the collection period, a statistical examination generates a weighted average and confidence interval of the dataset. This analysis ensures a time-balanced representative mean and standard error for each segment, adjusting for any inadvertent imbalance that may have occurred in execution of the drive plan.

Monitoring Methods and Equipment

What monitoring methods and equipment are being used Include instrument make, model, and characteristics.

Custom-designed Aclima mobile sensor nodes that measure carbon dioxide (CO_2), carbon monoxide (CO), nitric oxide (NO), nitrogen dioxide (NO_2), ozone (O_3), and particulate matter ($PM_{2.5}$) are installed in Aclima-operated vehicles. Each node has two distinct inlets, one for particles and one for the gas phase. The inlets are anchored in the rear, passenger side door of the Aclima vehicles with the inlets extending away from the vehicle surface to position them outside the vehicle's boundary layer. The mobile nodes also record multiple in-line temperature, pressure, relative humidity, and flow-rate measurements located in strategic locations to provide system state diagnostics and for use in our sensor models. Locations were measured with a GPS with a manufacturer reported 5m precision.

All 1-Hz measurements were synchronized using Network Time Protocol (NTP), which synchronizes the internal computer to Coordinated Universal Time (UTC). Each node records time using NTP and times are reported to the nearest segment in UTC.

The measurement method for each of the sensors employed in the mobile node are listed in Table 2, along with the reporting frequency and operation range.

Table 2: Aclima Mobile Node Sensor Parameters

Parameter	Measurement Method	Measurement Frequency	Operational Range
CO2	NDIR	1 sec	0-5000 ppm
CO	Electrochemical	1 sec	adjustable
NO	Electrochemical	1 sec	0-20 ppm, adjustable
NO2	Electrochemical	1 sec	0-2 ppm
PM (size resolved)	Optical	1 sec	0-300,000 #/L
O3	UV Spectroscopy	2 sec	0-100 ppm

Explain how these monitoring methods and equipment are suitable to meet monitoring objectives.

Mobile air monitoring provides a flexible method to measure data over large geographic areas at higher spatial resolution than feasible using conventional monitoring techniques. The collection methodology is designed to capture hyperlocal data representative of mean ambient concentration for each road segment over the collection period. These mean average concentrations are based on aggregate 1-Hz data points measured in individual road segments ~ 100m in length. This methodology aggregates more 1-Hz data points per road segment than the 30m segment lengths used in the previously published work that used a mobile laboratory containing reference instruments. Using a 100m road segment length reduces the impact of the difference in precision between sensors and laboratory-grade instruments.

Aclima targets a minimum of 20 samples per road segment, per collection period (for example, over the period of a quarter for a Quarterly Baseline dataset). These passes are distributed across different days of the week, and at different times of the day, to account for factors such as variation of weather and emission sources. By balancing sampling over time of day and day of week, we statistically account for these and other variations. Statistical methods are used to inform the data collection strategy as well as to assess the balance of the driving at the conclusion of the collection period. A weighted average is calculated for each road segment balanced across time of day, day of week, and distribution across the collection period to provide our best estimate of average ambient concentration as well as 95% confidence intervals around the weighted mean. Analysis of our sensor data indicates diminishing returns in narrowing our confidence intervals well below our 20 pass goal. The weight average, confidence interval, and other statistical variables reported per segment allow users to interpret the degree to which differences between segments are likely significant and what data merit more attention.

Please include or describe the field and/or laboratory Standard Operating Procedures that will be followed.

Drivers follow the Aclima Vehicle Operations Manual. This manual outlines procedures for safe operation of the vehicle, start up and shut down of the nodes, troubleshooting information, and accessing and executing that day's driving route assignments. Driving route assignments in the form of daily map-based drive plans are made using tools developed by Aclima engineers. Technical support is provided by Technical Operations.

Driver managers and Aclima technical staff follow procedures developed to interact with the driver when safety, car, communication, or measurement problems are detected. The procedures are designed to maximize the collection of valid data and ensure the safety of the drives. These procedures continuously evolve with lessons learned in the field.

Our sampling methodology was designed with the goal of collecting the most broadly representative data for a given area with high spatial resolution. Drive plans are designed to randomize data collection over a predefined geo-spatial region across temporal and spatial axes. Drive plans are constructed around geographic areas and designed to be drivable in time such that a number of these areas can be sampled during any drive shift. The drivers are directed to drive in that area until every publicly accessible and driveable stretch of road has been sampled. This has proven to be an effective strategy as it allows for randomized sampling at the neighborhood scale by time-of-day and day-of-week as well as an efficient way to communicate to the drivers. Drive plans are collaboratively developed by software engineering and driver operations staff and delivered directly to the drivers using advanced mapping software.

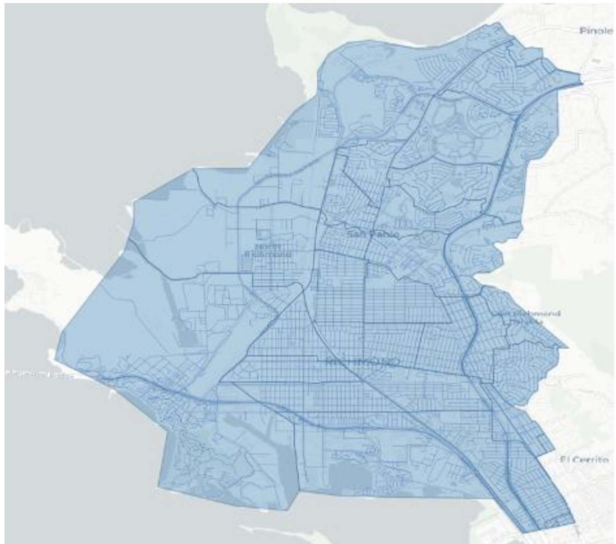
A number of processes and procedures have been implemented for data process and data review. These are outlined below as part of the Quality Control discussion.

Monitoring Areas

Where will monitoring be conducted within the community? Please include a map of monitor locations if possible.

Mobile mapping will encompass all of the publicly available streets in the contiguous Richmond and San Pablo cities as shown below.

Operational realities will naturally result in a small percentage of road segments with less than 20 measurements. Additionally, certain roadways are inaccessible for myriad reasons; anecdotally, our drivers have documented gated communities, private roads, downed trees, construction, freight operations, etc.



What is the rationale and considerations behind the monitoring locations?

The geographic boundary was defined by BAAQMD and the Richmond-San Pablo community steering committee and the region of interest for the AB617 program. Aclima mobile sensor-equipped fleet enables broad coverage and hyperlocal spatial resolution across the entire geographic boundary.

What are the characteristics of the monitoring locations (e.g., meteorology, sources, land use) and important logistical details (e.g., site access, security, power availability)?

The advantage of hyperlocal air quality monitoring is that these deployed air quality monitoring solutions don't rely on electricity, siting, and land-use constraints associated with traditional air quality monitors. Our fleet deploys on publicly accessible roadways. Aclima mobile monitoring platforms can drive near individual sources and varying distances from sources as well as from regulatory sites to allow for an understanding of spatial scales of representativeness of sources and stationary sites. In Solomon et al. (2020), results from mapping in Los Angeles with the Aclima mobile laboratory indicate that the regulatory sites do in fact achieve the spatial scales of representativeness intended.

Quality Control Procedures

What quality control activities are taking place for each type of measurement, and how often do those activities take place? Quality control activities may include reference materials, calibration, ongoing quality control measures (e.g., zero point, span point, one point), blanks, spikes, duplicates/collocation, and audits.

Mobile node sensors are calibrated by collocation with reference instruments in one of our mobile calibration platforms. Node and sensor performance are evaluated against reference instruments or collocated with an ensemble of sensors at 3 stages;

1. during the initial post-production, pre-deployment calibration,
2. during deployment by comparison with reference instruments measuring at NAAQS sites in the proximity of the data collection area,
3. post-deployment

Each stage is outlined in more detail below.

Pre-deployment calibration:

Aclima Mobile Nodes (AMNs) are calibrated immediately post-production (before deployment). Sensors located within the AMN are calibrated by collocation with reference instruments or with multiple sensors of the same make and model in one of our mobile calibration facilities. Calibration in our mobile facility ensures that the sensors are calibrated over the large dynamic range of analyte concentrations measured under atmospherically relevant on-road conditions. Calibrations are conducted by situating a sensor node in a vehicle with reference equipment and collocating their inlets so that they are essentially measuring the same air volume. The collocation period for AMN calibration includes a calibration "training" period to derive input parameters for the sensor models, followed by a "testing" period to verify the input parameters and quantify sensor performance.

The reference instruments used for the calibration of the O_3, NO_2, NO, and CO_2 sensors are routinely calibrated using traceable gas standards based on manufacturer specifications or returned to the vendor for re-calibration. Performance of the gas phase reference instruments is assessed based on the results of weekly span and zero checks.

The performance of the CO and $PM_{2.5}$ sensors are evaluated primarily via manufacturer calibrations and collocations between sensors. The reference $PM_{2.5}$ sensor is periodically returned to the manufacturer when the results of ambient collocations indicate substantial drift or based on a period specified by the manufacturer.

If any sensor does not meet our stated acceptance criteria, all aspects of the sensor operation are investigated until the cause is found and either corrected or if it cannot be, the sensor is replaced. No AMN is released for deployment until all acceptance criteria are met.

Data assessment during deployment:

A number of procedures are used to assess data quality during deployment or active mapping.

Data reported by the AMNs are monitored daily by Aclima Drive Operations and technical staff and steps are taken as soon as possible to correct a problem once identified. If possible, Aclima staff work with the driver to make the needed repairs. If problems persist, the driver can bring the node in for servicing or replacement.

Aclima's data ingestion and processing system has been configured to send a number of alerts to technical staff when any anomaly is detected. These include no data being reported from a device that is known to be on, low flow rates, sensor data out of range, and others. When a notification is received, Aclima technical staff work with the drivers to investigate and fix the fault if possible. If not, the problem is noted and a plan for service is developed.

During deployment, a team of scientists, engineers, and data analysts manually review the data from the entire fleet network on a weekly basis and at the end of contracted driving periods (quarterly and yearly). This process consists of a number of steps: (1) monitoring of weekly time series of gas and particle concentrations as well as secondary parameters like temperature, pressure, relative humidity, and flow rate along with data quality status indicators, comparing groups of cars that are mapping the same contracted region, and data completeness; (2) checking correlations among pollutants that are expected to correlate; and (3) comparisons of collocated vehicles with available regulatory data, other fixed sites, and vehicle-to-vehicle. If a data irregularity is observed during this review process, it is noted in an internal built-for-purpose database and stored permanently in the cloud. Corrective action is logged by the individual performing the work in an electronic log tied to the specific node and/or sensor being worked on (identified by serial number). A node/sensor database is also kept that links each unique instrument (by serial number) to preventative maintenance due dates. The irregularity is thoroughly investigated with follow up that includes, for example, adjusting calibration values, excluding the data, or placing on a watch list for further consideration. Once a solution is identified and resolved, the database is adjusted if required (as discussed in the next section).

Post deployment recalibration

When returned to our facility after deployment in the field, the node is calibrated using the same process outlined above. The same acceptance criteria are applied to the returned node. If the performance of any sensor does not meet the acceptance criteria, then an adjustment to the data is applied. (Note that any sensor reporting invalid data will have been identified before a node is returned for recalibration, so the data from the node has been reviewed and found to correlate well with nearby mobile nodes and relevant stationary measurements.) The collocation data is used to verify that the adjustment is adequate. We use a correlation check (e.g. r2 > 0.8) to determine if it is valid to apply a calibration adjustment.

Other quality assurance processes

Preventative maintenance tasks and typical frequency:

- In-line gas sensor filters are replaced during node recalibration, which typically occurs between 6 months to a year;

- PM sheath air filters are replaced during node recalibration, which typically occurs between 6 months to a year
- Other consumable materials are replaced on an annual basis

What procedures or measures are taken when quality control limits are exceeded?

Aclima engineers and technical staff work with drivers to perform simpler fixes in the field. If not possible or if in-field service impacts performance the node is returned to Aclima's facility for service and repair or swapped for a newly calibrated node. The returned device is fixed, recalibrated, and ready to be re-deployed as needed.

Data Management

In addition to collecting the measured value of interest, what data descriptors are included (e.g., instrument identifiers, date/time stamps, units, etc.)?

The mobile node records each raw sensor measurement, the date, time, and location of the measurement, and the other diagnostic data measured by the system including sensor specific temperature, pressure, relative humidity, flow rate, and other data used to verify that the node is operating correctly and that might be needed to include in sensor models. Metadata including sensor and node identifiers, units of measurement, and other relevant information is also associated with each measurement. Sensors are tracked throughout by project, serial number, parameter, model and start and stop time of use.

How are data being stored? For example, are they stored in a database? Are additional attributes like data quality indicators and data qualifiers stored as well?

The mobile node has measurement, control, and communications integrated into the device. The node has the ability to send data messages directly to the cloud through either an internal LTE module or WiFi. All raw sensor readings, location, and diagnostic data are packaged into coded messages with an associated network timestamp and transmitted to an Aclima back-end platform primarily via LTE. The data is then decoded and sent to a cloud-based data store for permanent storage. The node contains enough flash storage to store up to a few weeks of 1 second data. During times when LTE connectivity is poor, data messages are queued on the device and sent when connectivity returns.

On a nightly basis, the raw data from the node is extracted and transformed into a cloud database with all appropriate diagnostic variables and quality flags for subsequent processing to support Aclima data products.

What data review and flagging procedures are in place? For example, are calibrations and incomplete sample periods excluded from data aggregations?

Processes are primarily described above. Data is never removed from the initial back end data store. All exclusions based on diagnostic data or quality flags occur during the extraction and transformation of the data that support our downstream data processing pipeline.

Work Plan for Field Measurements

What field procedures and materials are being used to conduct monitoring?

Field procedures and materials were described above. All monitoring work under this project will be conducted by trained Aclima staff.

Please provide a timeline for air monitoring duration, frequency, and milestones.

Monitoring will begin on August 1, 2019 and proceed through the end of October. Measurements will be distributed across all days of the week and all hours of the day during the collection period. The exact day and time that drivers will be present are determined by our driving plan for each specific vehicle.

Evaluating Effectiveness

What process is being used to ensure that air monitoring objectives are being met? How often are those evaluations conducted? How are effectiveness issues documented and addressed?

Data from the mobile mapping campaign will be quality controlled and analyzed both during collection and after collection is completed to ensure that the data are of the highest quality possible to meet data quality objectives and provide robust segment aggregates for all publicly available roads in the Richmond-San Pablo monitoring area. Aclima staff will meet regularly to assess the status of the mapping effort, vehicle and node performance, and data quality. Any problems or irregularities will be logged, investigated, and suitable corrective actions implemented as soon as possible. Ensuring technical success of the mapping campaign underpins the effectiveness of the broader community-level objectives and outputs described below.

What is the end point for air monitoring with this project?

Aclima will provide a quarterly baseline for August through October 2019 to support emissions and exposure reduction efforts in Richmond-San Pablo as part of the community and air district's AB617 efforts. Aclima will publish these results in presentations and briefings, and provides pollution maps by segment, free to the public, through its Insights web page (https://insights.aclima.io/richmond-san-pablo). Aclima plans to continue to map this area as part of its mapping of Contra Costa County at annual baseline resolution.

Analyze and Interpret Data

What is the overall approach for preparing, analyzing and interpreting data to address project objectives?

As discussed above, Aclima has an extensive process for ensuring the quality of measurements obtained by our mobile platforms. The primary focus currently is to provide data to the public through Insights and to regulators through Aclima Pro. These programs provide spatial pollutant displays at 100 m scale as road segments, allowing community members to note locations of lower and higher pollution and identify particular hot spots or regions of concern.

Aclima is continually improving its data presentation approach to connect with diverse audiences, spanning members of the public learning about air quality for the first time, to providing information for proficient frontline community members as well as government regulators. User-centered design requires us to continually evaluate how to better translate data and findings into specific use cases for our user groups. This is an iterative process requiring ongoing dialogue and exchange.

Communicate Results

How frequently and in what format (e.g., factsheets, reports) will information be shared with the community throughout the air monitoring process?

Results are presented and communicated via several formats and settings to ensure broad access and understanding of both our methods and the results. The following outline lists key activities in Richmond-San Pablo:

- Approximately 290 staff hours invested in direct engagement, including:
  - attending 8 Steering Committee meetings
  - the November Path to Clean Air in Richmond
  - San Pablo Community Summit
  - interviews with Steering Committee Co-Leads
- Distribution of multilingual factsheets
- Publication of monitoring results in an interactive, free report at https://insights.aclima.io/richmond-san-pablo
- In-person training sessions familiarizing Steering Committee members with the interactive report on March 4, 2020
- Preparation of virtual video trainings and Q&A
- Ongoing coordination with other non-Aclima monitoring initiatives to ingest their data into the interactive report.

Aclima is committed to continued engagement and support as the region continues monitoring and implements emissions reductions.

APPENDIX D: GROUNDWORK RICHMOND PROJECT INFORMATION

Please find information on this project on the next page.

AB 617 Richmond-San Pablo Community Monitoring Plan Elements

Project name: Air Rangers: Citizen Science Environmental Monitoring Capacity Building Program

Project organizers: Groundwork Richmond and Ramboll

The Steering Committee identified air quality concerns across Richmond-San Pablo through a series of mapping activities and discussions. These concerns were wide-ranging, including specific large and small stationary sources and mobile sources such as freeways, railways, and shipping. The Steering Committee determined that air quality screening data across the entire Richmond-San Pablo area would be helpful to identify and better understand sources of concern, locate possible hotspots for certain air pollutants, compare air quality across neighborhoods, and inform development of additional monitoring projects.

Define Air Monitoring Objectives

What are the objectives of this air monitoring project?

- Cooperatively integrate the Bay Area Air Quality Management District's AB 617 efforts, knowledge and expertise with the California Air Resources Board Community Air Grants in the Richmond San Pablo emissions monitoring study area.
- Provide real-time, exposure-relevant, and actionable air quality information to Richmond residents, filling gaps in existing monitoring networks, especially in SB 535 disadvantaged communities
    - inform citizen recreation
    - provide a dataset that may eventually be useful in understanding and communicating the impacts of city forestry on local air quality and advocating for cleaner CALTRANS
    - collect data to inform air quality improvement strategies and mitigation measures
- Better understand the contributors to exposure-relevant PM2.5 and health-relevant airborne metals concentrations in Richmond, CA
- Through training and implementation of the monitoring network, provide local youth with marketable, employable skills in the air monitoring space and allow Groundwork to integrate further into the environmental monitoring movement.

What will be measured, when and where will it be measured, and why?

PM2.5 is being measured over the course of one year at 50 sensor locations. Sensor locations were selected based on the following criteria:

- Input from the Richmond community
- Prioritizing areas of citizen recreation
- Prioritizing proximity to major freeways and thoroughfares

This pollutant was selected because it is a combustion-related pollutant and originates from traffic sources. Urban traffic is known to be one of the major contributors to localized pollution burden and Richmond is straddled by two major freeways.

Gravimetric assessment of PM2.5 and PM10 will be performed at a subset of those 50 sensor sites. Considerations will be made for seasonality, data quality, and repeatability. Filters will be assessed for concentrations of a variety of health-relevant metals. This sampling method and pollutant were selected because (1) this method provides periodic colocation to check data quality from sensors, (2) this can provide spatial and temporal information about metals in Richmond, and (3) serves as a training opportunity for the Air Rangers to learn a complex and valuable air monitoring skill.

Roles and Responsibilities

What parties are responsible for major aspects or phases of air monitoring? What are the roles of these parties?

Subcontractor Ramboll has provided standard operating procedures, guidelines, and training on all major aspects of the air monitoring program and assisted with data quality procedures and data analysis. The Groundwork Air Rangers have performed the implementation - deploying the low-cost sensors network and performing the metals gravimetric sampling. The City of Richmond has facilitated with support on permitting and site access.

What are the training requirements for individuals conducting air monitoring?

Participation in training sessions, review of SOPs, accompanied during first sampling campaign, and review of all field forms.

Define Data Quality Objectives

What are the performance and acceptance criteria for collected data?

We evaluated sensor performance with the following metrics: precision, linearity, bias, data completeness. A "detection limit" was also evaluated based on a co-location study testing the performance of sensors prior to deployment in the field.

Model bias is also calculated.

What criteria are being used for precision, bias, accuracy, sensitivity, and data completeness?

Linearity (or correlation) was determined by colocation with an FEM monitor. Criteria was to use instruments with moderate or better linearity with FEM measurements ($R2 > 0.5$)

Precision was evaluated through intra-device variability among all sensors in the network. Criteria was for relative intra-model variability to be < 20%.

Bias (accuracy) was evaluated as the degree of closeness of sensor concentration measurements to the actual (true) concentration value measured using an FEM instrument. The bias measured during the initial colocation study was used to calibrate sensors to reduce bias.

Model bias was evaluated as the degree of closeness of model concentration estimates to the actual (true) concentration value measured using an FEM instrument as well as bias with sensor measurements.

Data completeness was evaluated on an hourly basis. Greater than 90% data completeness is allowable and completeness is always flagged.

“Detection limit” was evaluated by investigating linearity at the lowest concentrations.

What is the temporal and spatial representativeness of the monitoring?

Sensors capture data approximately every 10-15 minutes (and this is reported on a web application in real-time). For analysis and input into the Shair model, sensor data is averaged to hourly values. The model is executed every hour to represent that hour’s real-time forecast. Fifty sensors are used across the City of Richmond, at a density of approximately one sensor for every 1-2 square kilometers. The model is a fusion between a 10-meter resolution roadway dispersion model and a 200-meter resolution regional photochemical model.

Monitoring Methods and Equipment

What monitoring methods and equipment are being used? Include instrument make, model, and characteristics.

Clarity Node-S Cellular version sensor measuring NO_2 (electrochemical) and PM2.5 (optical).

MiniVol Tactical Air Sampler units (“MiniVol” or “MiniVol TAS”) to measure particulate matter (PM) and toxic metals.

Explain how these monitoring methods and equipment are suitable to meet monitoring objectives.

Sensors are suitable to provide real-time indicative estimates of PM2.5 and NO_2 to better understand relative gradients in air pollution across Richmond and fill spatial gaps where measurements do not currently exist.

Minivol measurements provide important workforce development skills to the Air Rangers as gravimetric PM sampling is a skill used across the environmental monitoring space. These gravimetric measurements also help with data quality objectives and indicators of the project.

Please include or describe the field and/or laboratory Standard Operating Procedures that will be followed.

Please see attached MiniVol SOP.

Monitoring Areas

Where will monitoring be conducted within the community? Please include a map of monitor locations if possible.

Continuous monitoring is being conducted at the circles included on the map below, the gravimetric sampling will be 24-hour samples at a subset of those locations. Modeling occurs across the City of Richmond within the domain shown below.

What is the rationale and considerations behind the monitoring locations?

Sensor locations were selected based on the following criteria:

- Input from the Richmond community
- Prioritizing areas of citizen recreation
- Prioritizing proximity to major freeways and thoroughfares
- Permission through the City of Richmond encroachment permit

What are the characteristics of the monitoring locations (e.g., meteorology, sources, land use) and important logistical details (e.g., site access, security, power availability)?

- Meet monitoring objectives and rationale (see above)
- Maintain unrestricted flow boundary
- Meet siting verification criteria such as:
  - Proper orientation of solar panel
  - Sufficient distance from any local pollution source
  - Free of obstructions
  - Secure from theft and vandalism

Quality Control Procedures

What quality control activities are taking place for each type of measurement, and how often do those activities take place? Quality control activities may include reference materials, calibration, ongoing quality control measures (e.g., zero point, span point, one point), blanks, spikes, duplicates/collocation, and audits.

An initial colocation was used to quantify sensor performance prior to deployment and measure linearity, bias, precision, and data completeness alongside an FEM.

Minivol sampling will be periodically colocated to sensor locations to compare gravimetric sampling with time-averaged sensor readings.

Sensor calibration is checked and updated on a monthly basis. This calibration procedure checks and removes NO2 data where RH is below the 30th percentile of RH measurements (electrochemical cell is less stable during low humidity periods). The calibration procedure also resets the NO2 baseline and PM2.5 scaling factor based on the co-location to the reference monitor.

Ongoing weekly checks occur on the data through a dashboard to determine if any outliers exist.

For minivol sampling, one blank will be collected at every location and sampling day.

What procedures or measures are taken when quality control limits are exceeded?

Sensors exhibiting strange signals (flat-lining, out of bounds, drift, poor coalition linearity) are removed from the dataset.

If a Minivol blank has a positive detection, samples from that day will be removed from the analysis.

Data Management

In addition to collecting the measured value of interest, what data descriptors are included (e.g., instrument identifiers, date/time stamps, units, etc.)?

For sensors: Node ID, site location with lat/lon, pictures of site and sensor, nearest roadway and nearest source, height above ground, angle of obstruction and nearest obstruction, timestamps, units)

For Minivol samples: Site location, date and time, person sampling, any field observations, a chain of custody form.

How are data being stored? For example, are they stored in a database? Are additional attributes like data quality indicators and data qualifiers stored as well?

All sensor and model data are being stored in a database.

Chain of custody forms are being scanned and stored. Results from Minivol sampling are being compiled into Excel spreadsheets.

What data review and flagging procedures are in place? For example, are calibrations and incomplete sample periods excluded from data aggregations?

Model data incompleteness is flagged and is re-run to complete the dataset. Data is not aggregated unless the 90% data completeness threshold is passed.

Incomplete data from sensors is flagged so that data completeness can be calculated. Data is still aggregated but completeness is noted.

Work Plan for Field Measurements

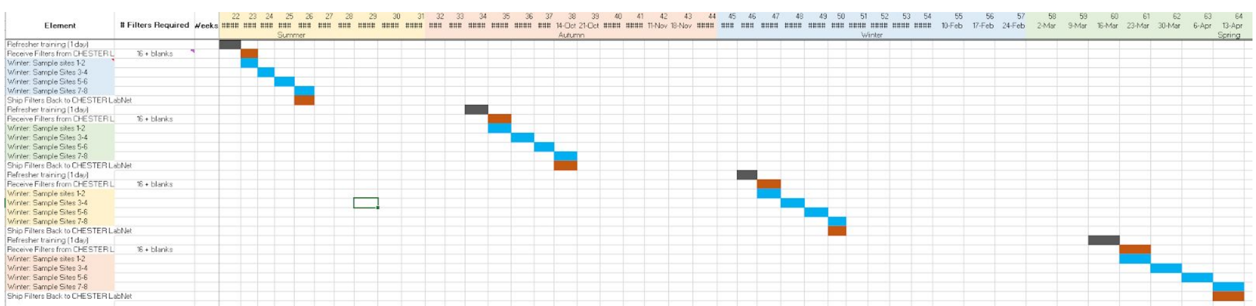
What field procedures and materials are being used to conduct monitoring?

See attached Site Verification, Deployment, and MiniVol SOPs.

Please provide a timeline for air monitoring duration, frequency, and milestones.

Task #	Task/Subtask Name	Deliverable	Start Date	Due Date	Partner
1	**Project Design**				
1.1	Proposal Refinement	Updated plan based on agreement from BAAQMD, CARB, and partners	Week 1 (assume Sept 2018)	Week 4	All
1.2	Site Selection	Confirmed 50 sites for Clarity Nodes	Week 4	Week 8	All
2	**Project Management**				
2.1	Deployment Management	Permits, Equipment procured for deployment	Week 6	Week 16	City of Richmond
2.2	Organize Community Teams	Kick-off meeting with community teams	Week 4	Week 16	Groundwork Richmond
2.3	Sensor Network Operation Management	On-line and operational sensor network	Week 16	Week 68	Ramboll
2.4	Decommissioning	All sensors removed from Richmond after one year (OPTIONAL)	Week 68	Week 70	City of Richmond
3	**Data Collection**				
3.1	Procurement of Clarity Nodes	50 Clarity Nodes	Week 2	Week 8	Ramboll
3.2	Deployment of Sensors	Deployment of 50 Sensors at Selected Sites	Week 9	Week 16	City of Richmond, Ramboll
3.3	High Volume Sampling	Toxics speciation results for 70 samples taken throughout the course of one year	Week 16	Week 68	Groundwork Richmond, Ramboll
3.4	Maintenance of Deployed Sensors	Repair or replacement of Nodes	On-going	On-going	Ramboll
4	**Data Analysis and Real-Time Modeling**				
4.1	Data Analysis	SIRANE deployment, real-time high-resolution model for Richmond	Week 16	Week 68	Ramboll
5	**Data Syntheses and Presentation**				
5.1	Centralized Dashboard	Access to Centralized Dashboard	Week 16	On-going	City of Richmond

5.2	CARB Reporting	Mid-project report detailing summary of work completed, expenditures, and results	Week 38	Week 38	All
5.3	CARB Reporting	Annual report detailing summary of work completed, expenditures, and results	Week 76	Week 76	All
5.4	Quarterly Online Progress Reports	Quarterly progress bullets on the Dashboard	On-going	On-going	All
6	**Community Engagement**				
6.1	Citizen Web App & App Adaptation	Web and Mobile App for Richmond Citizens	Week 2	Week 14	All
6.2	Social Media Outreach	E-Mail Blasts, Twitter, Facebook, announcing milestones; w/ weekly posts on instagram & twitter providing updates from Green Team and Green Corps installation & deployment activities	Week 1	week 76	Groundwork Richmond
6.3	Conference Presentations	NPS Science Symposium; YES Conference; GWUSA Summits; RTCA/NPS Clear Skies	TBD	On-going	Groundwork Richmond
6.4	School Site Programming	presentations & district wide flier distribution	TBD	On-going	Groundwork Richmond
6.5	Community Workshop - Dissemination of Results	Workshops and other activities to engage community and create awareness of the network and the data generated	Week 3	On-going	Groundwork Richmond



Evaluating Effectiveness

What process is being used to ensure that air monitoring objectives are being met? How often are those evaluations conducted? How are effectiveness issues documented and addressed?

The Air Rangers program is supported through an agreement with the California Air Resources Board. That agreement requires *Annual*, *Semi-Annual* and *Interim Billing* reports to ensure that objectives are being met. Issues are documented in these reports and are addressed via regular oversight meetinga with the agreement's grant manager.

What is the end point for air monitoring with this project?

After one year of data collection from sensors and Minivol samples, the air monitoring portion of the project is complete and data/learnings will be reported. These outputs are intended to increase participation among Richmond Residents in the regulatory process to reduce local exposure rates and hospitalizations.

Analyze and Interpret Data

What is the overall approach for preparing, analyzing and interpreting data to address project objectives?

Data analysis and interpretation is approached in three ways:

(1) real-time information undergoes automated QA/QC checks and occasional in-person inspection but the timeliness of the data to the public is the top importance and therefore is made available in real-time and is marked as "preliminary" and not quality controlled. Interesting insights can be made from this data at the hourly time-scale.

(2) Monthly calibration and checks of data performance occur to ensure ongoing data collection and generation is of high quality

(3) At the end of the sampling campaigns, a more in-depth analysis and interpretation will occur once the dataset is complete to investigate the remaining project objectives/questions.

Communicate Results

How frequently and in what format (e.g., factsheets, reports, meetings) will information be shared with the community throughout the air monitoring process?

Model and sensor information is available in real-time through the internet on any mobile, tablet or desktop computer through a browser window.

https://app.ramboll-shair.com/richmond

https://www.transparentrichmond.org/stories/s/2ag9-azjv

Multiple types of visualizations can be generated from these websites. Real-time hourly information as well as time-averaged aggregate maps.

Preliminary results are shared through presentations at Steering Committee meetings.

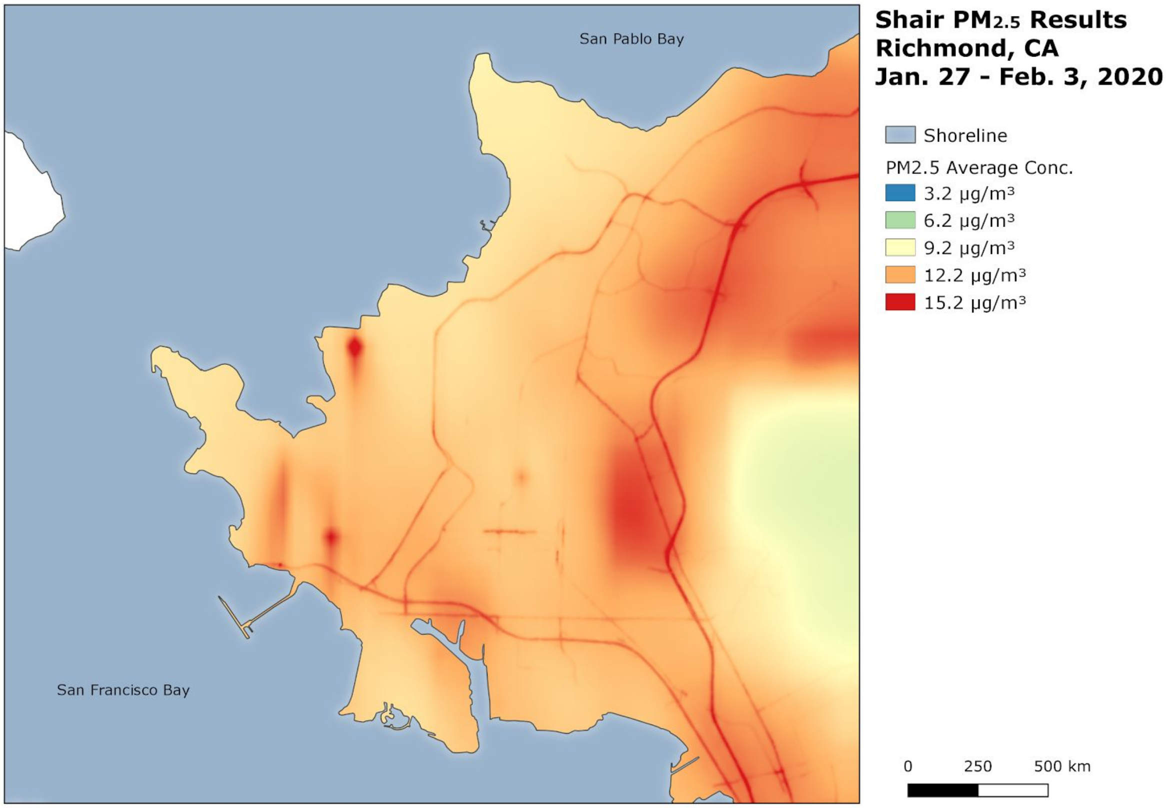
Project updates are made through social media.

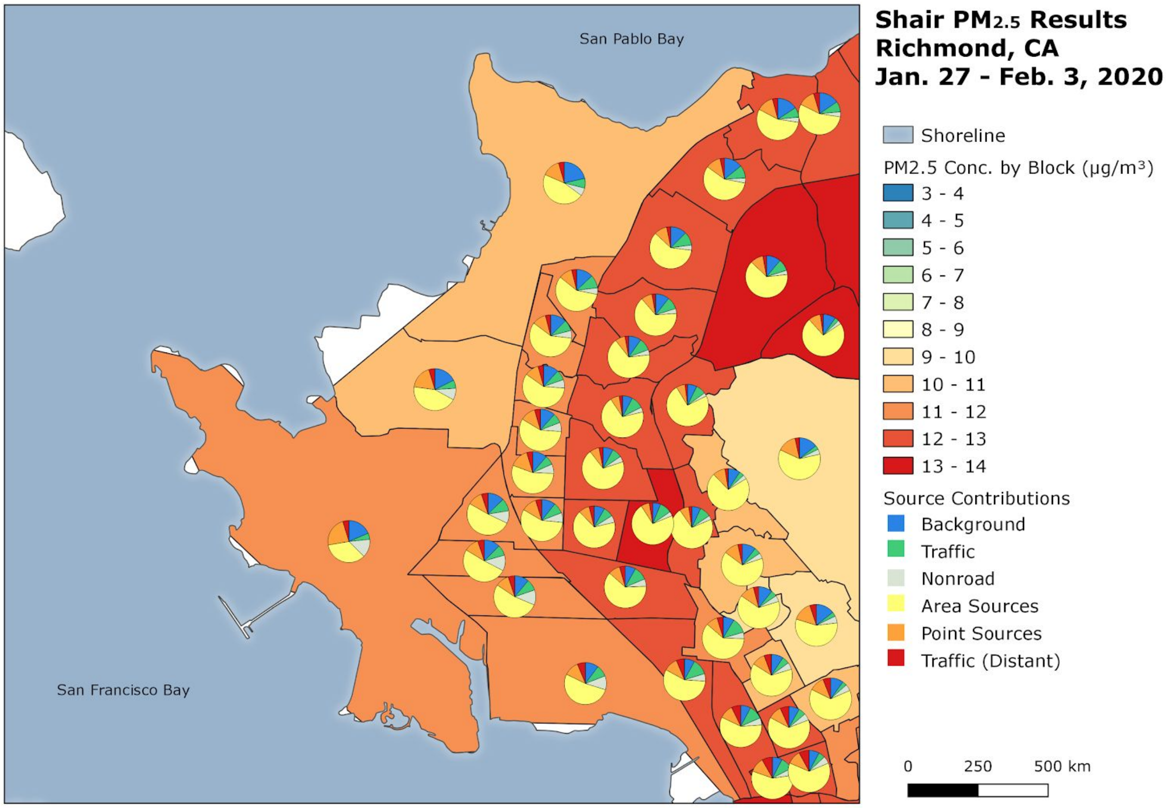
Reporting is sent to the California Air Resources Board.

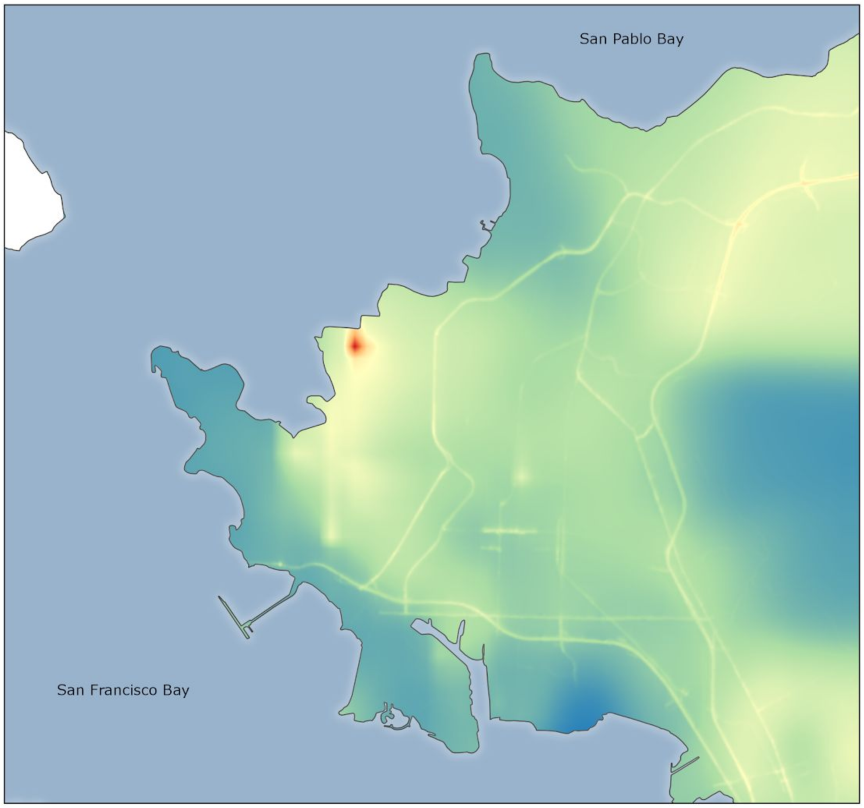
Examples of the types of maps that can be generated:

Not seeing your city or area?
CITY: Richmond, CA
PRO
MODE: Nowcast
Search Address...
Novato
Black Point
Sears Point
San Pablo Bay Wildlife Area
San Pablo Bay National Wildlife Refuge
San Pablo Bay
McNears Beach
Sobrante
Point Pinole Regional Shoreline
Rheem
San Pablo
North Richmond
Richmond
Castro St
Dunn Ave
Bissell Ave
MARINA BAY
UC Berkeley Richmond Field
Jun 11 2020, 10:00 pm
-48
-24
Now


2876 El Portal Dr, San Pablo, CA 94806...
Not seeing your city or area?
CITY: Richmond, CA
PRO
MODE: Historical
PRO ACCESS
POLLUTANT: $PM_{2.5}$
PERIOD: Daily
DAY: Jun 9, 2020
Contributors
12 μg/m^3
Background 34%
Trafic inside modeling domain 12%
Trafic outside modeling domain 4%
Non-road 5%
Area 15%
Point 8%
Unknown 23%
$PM_{2.5}$ Concentration
12 μg/m^3
10-25 μg/m^3
Daily average for Jun 9, 2020
San Pablo Bay National Wildlife Refuge
San Pablo Bay Wildlife Area
San Pablo Bay
McNears Beach
Pinole
El Sobra
Rheem
North Richmond
San Pablo
East Richmond Heights
Richmond
POINT RICHMOND
Cutting Blvd
Potrero Ave
MARINA BAY
UC Berkeley — Richmond Field Station
El Cerrito
ALBANY HILL
John T. Knox Fwy


San Pablo Bay
San Francisco Bay
Shair PM2.5 Results
Richmond, CA
Jan. 27 - Feb. 3, 2020
Shoreline
PM2.5 Average Conc.
3.2 µg/m³
6.2 µg/m³
9.2 µg/m³
12.2 µg/m³
15.2 µg/m³
0
250
500 km


Shair PM2.5 Results
Richmond, CA
Jan. 27 - Feb. 3, 2020
San Pablo Bay
San Francisco Bay
Shoreline
PM2.5 Conc. by Block (µg/m³)
3 - 4
4 - 5
5 - 6
6 - 7
7 - 8
8 - 9
9 - 10
10 - 11
11 - 12
12 - 13
13 - 14
Source Contributions
Background
Traffic
Nonroad
Area Sources
Point Sources
Traffic (Distant)
0
250
500 km



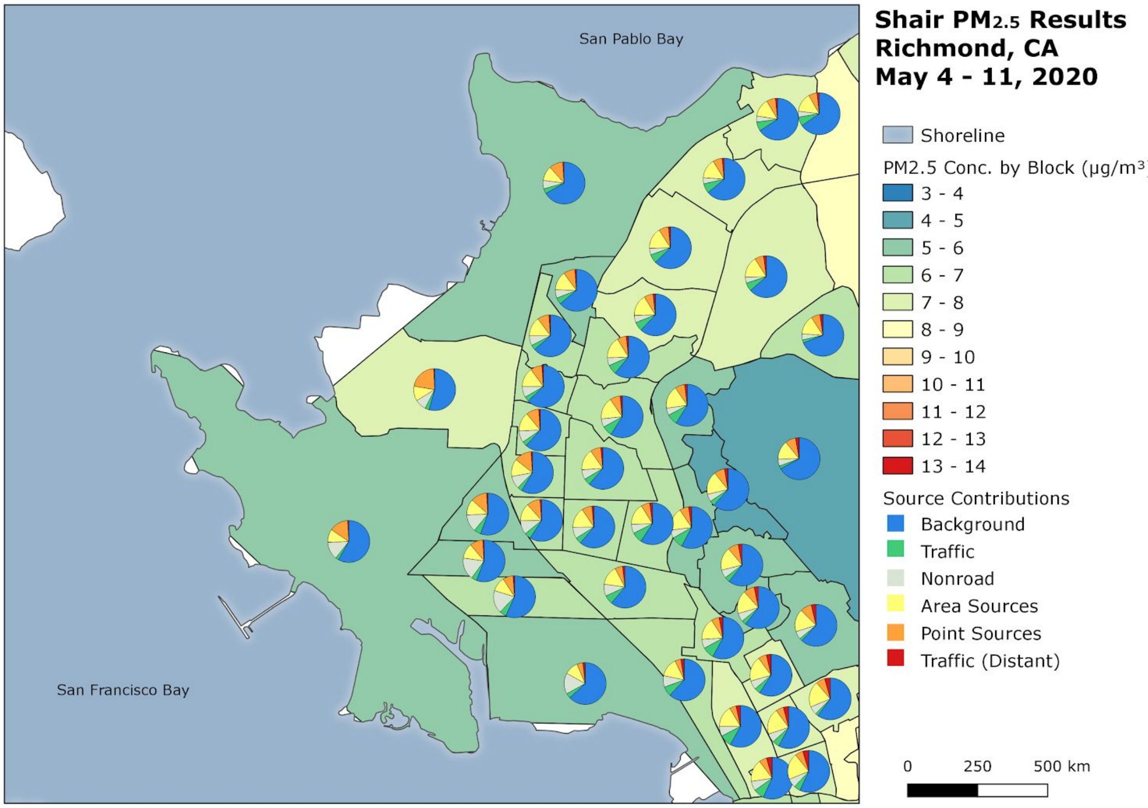
Shair $PM_{2.5}$ Results
Richmond, CA
May 4 - 11, 2020

Shoreline

PM2.5 Average Conc.

- 3.2 µg/m³
- 6.2 µg/m³
- 9.2 µg/m³
- 12.2 µg/m³
- 15.2 µg/m³

0 250 500 km


Shair PM2.5 Results
Richmond, CA
May 4 - 11, 2020
Shoreline
PM2.5 Conc. by Block (μg/m³)
3 - 4
4 - 5
5 - 6
6 - 7
7 - 8
8 - 9
9 - 10
10 - 11
11 - 12
12 - 13
13 - 14
Source Contributions
Background
Traffic
Nonroad
Area Sources
Point Sources
Traffic (Distant)
0 250 500 km
San Pablo Bay
San Francisco Bay

APPENDIX E: PSE HEALTHY ENERGY PROJECT INFORMATION

Please find information on this project on the next page.

AB 617 Richmond-San Pablo Community Monitoring Plan Elements

Project name: Richmond Air Monitoring Network

Project organizers: Physicians, Scientists, and Engineers for Healthy Energy (PSE) and Asian Pacific Environmental Network (APEN)

The Steering Committee identified air quality concerns across Richmond-San Pablo through a series of mapping activities and discussions. These concerns were wide-ranging, including specific large and small stationary sources and mobile sources such as freeways, railways, and shipping. The Steering Committee determined that air quality screening data across the entire Richmond-San Pablo area would be helpful to identify and better understand sources of concern, locate possible hotspots for certain air pollutants, compare air quality across neighborhoods, and inform development of additional monitoring projects.

Define Air Monitoring Objectives

What are the objectives of this air monitoring project?

- Characterize ambient concentrations of several criteria air pollutants; provide reliable, hyperlocal air quality data to the community and regulators.
- Assess the spatial and temporal variability of air pollution and compare air quality across neighborhoods and in areas experiencing disproportionate impacts.
- Identify local sources of emissions and short-lived pollution episodes, locate hotspots and screen areas of concern within the community.
- Community engagement: raise awareness and encourage community participation; foster collaborative partnerships related to local air monitoring; provide real-time air quality information to inform residents of current conditions within the community.
- Policy engagement: translate our data collection efforts into decision making on local, regional and statewide level; inform the Community Air Monitoring Plan process and future development of a Community Emissions Reduction Plan.

What will be measured, when and where will it be measured, and why?

- 50 Monitors will measure $PM_{2.5}$, O_3, NO_2, temperature and relative humidity (RH)
- 3 monitors will measure total VOCs, CO, $PM_{2.5}$, temperature and RH.
- Data will be collected for a period of at least a year between 2020-2021 and will cover areas throughout Richmond, North Richmond and San Pablo.
- See objectives and goals outlined above.

Roles and Responsibilities

What parties are responsible for major aspects or phases of air monitoring? What are the roles of these parties?

PSE is the project lead responsible for air monitor deployments, data collection, data analysis, and reporting of results.

Aeroqual Ltd. is providing the AQY air monitors and technical support.

Aclima is helping with real-time data visualization and a community data portal.

APEN is helping with community outreach and community engagement.

What are the training requirements for individuals conducting air monitoring?

All aspects of the air monitoring will be conducted by qualified PSE staff.

Define Data Quality Objectives

What are the performance and acceptance criteria for collected data?

For low-cost instruments, we use "instrument reliability" as a measure to evaluate instrument performance. This measure is less restrictive than compliance but still requires certain conditions to be met in order to have confidence in the data within well-defined constraints. We use specific exceedance thresholds based on the maximum variability for transfer standard accuracy and for indicative measurement suggested by the U.S. EPA.[1,2]

What criteria are being used for precision, bias, accuracy, sensitivity, and data completeness?

Criteria used are based on EPA recommendations[1,2] and the following Aeroqual AQY instrument specifications:

AQY specifications

PARTICLE MODULE	SIZES	RANGE	ACCURACY	FLOW RATE	LOWER DETECTABLE LIMIT (2σ)
Particle Counter	$PM_{2.5}$	0 to 1000 µg/m³	<±(10 µg/m + 5% of reading)	0.5 LPM	<1 µg/m³

GAS MODULE	RANGE (ppb)	RESOLUTION / ppb	NOISE	LOWER DETECTION LIMIT / ppb	PRECISION	LINEARITY (% OF FS)	DRIFT 24 HOUR
			ZERO / ppb; SPAN % OF READING				ZERO / ppb; SPAN % OF FS
Ozone (O_3)	0-200	1	<1 <2%	1	<4% of reading or 4 ppb	<3%	<2; 1%
Nitrogen Dioxide (NO_2)	0-500	1	<2 <4%	2	<8% of reading or 8 ppb	<6%	<4; 1%

We are aiming for precision and bias error of < 20% and data completeness > 80%.

What is the temporal and spatial representativeness of the monitoring?

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[1] Environmental Protection Agency. *Air Sensor Guidebook.* EPA 600/R-14/159, 2014

[2] Environmental Protection Agency. *Quality Assurance Handbook for Air Pollution Measurement Systems – Volume Two*. EPA-454/B-13-003, 2013

Monitors are collecting and reporting measurements every minute. Data aggregated on 5-min, 10-min, hourly, daily and monthly timescales will ensure temporal representativeness with regard to the hourly, daily, and seasonal variability of air pollution in the area.

Fifty instruments are to be deployed within an area of approximately 15 square miles. The high spatial density of the network will ensure spatial representativeness of every community within the study area.

Monitoring Methods and Equipment

What monitoring methods and equipment are being used? Include instrument make, model, and characteristics.

The monitoring method is a saturation method using dense sensor network of stationary monitors. The instrument is made by Aeroqual, the model is the Aeroqual AQY, with the following characteristics:[3,4]

SYSTEM SPECIFICATIONS	
Control System	Single board computer, 1.2GHz quad-core, 1GB SDRAM, 16GB SDHC Storage, Ubuntu Linux Operating System
Communications	Standard: WIFI Optional: Cellular HSPA/4G-LTE modem Optional: Silver Springs Network Edge Router (mesh network)
Software	Connect: Runs on single board computer, accessed via web browser (IE, Firefox, Chrome, Safari) Cloud: Runs on secure 'cloud' servers, accessed via web browser Connect / Cloud Features: configuration, diagnostics, journal, calibration and data acquisition, plus SMS and email alerts, auto data export via FTP and email, and data export API
Data logging	16GB Hard Drive (>2 years data storage)
Averaging period	1 min, 5 min, 10 min, 15 min, 20 min, 30 min, 1 hr, 2 hr, 4 hr, 8 hr, 12 hr, 24 hr
Power requirements	12VDC plug pack (US plug): 24W
Enclosure	IP33 enclosure with integrated aluminium solar shield armour
PM Sampling System	Inlet: 4cm aluminium inlet Sampling: 5V DC fan
Gas Sampling System	Inlet: Teflon, stainless steel Sampling: 5V DC fan
Dimensions	215H x 170W x 125D mm (including solar shield armour & mounting brackets)
Weight	<1 kg
Environmental operating range	0°C to +40°C
Mounting	Pole, tripod and wall mounting bracket included

[3] https://www.aeroqual.com/product/aqy-micro-air-quality-station
[4] https://www.aeroqual.com/aqy-smart-air-quality-monitor

Explain how these monitoring methods and equipment are suitable to meet monitoring objectives.

Aeroqual AQY monitors are designed to measure the criteria air pollutants that are the focus of our study ($PM_{2.5}$, O_3, NO_2) with high accuracy and ease of operation. They are also designed to perform reliably over extended periods of time, which is crucial for a longitudinal study like ours. The monitors have been extensively evaluated by the SCAQMD AQ-SPEC program to correlate performance with Federal Reference Methods,[5] have received high performance grades during evaluations, and have been subsequently deployed in the field by the SCAQMD.

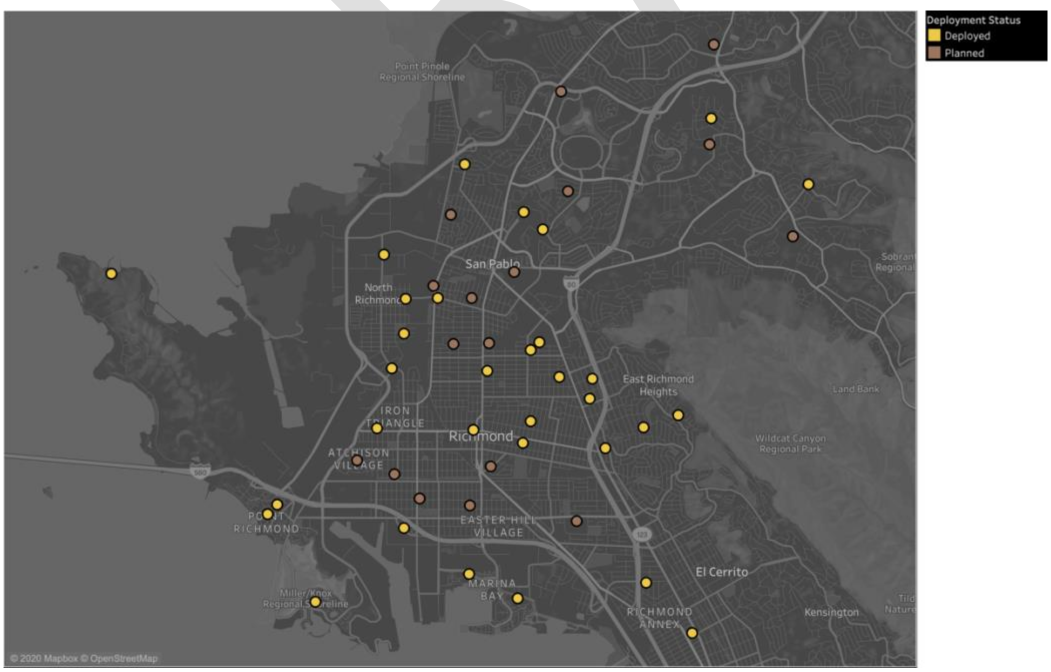
Please include or describe the field and/or laboratory Standard Operating Procedures that will be followed.

Aeroqual AQY monitors are designed for ease of operation to reduce operating procedures and costs. Once monitors are installed and mains-powered, data are automatically communicated via 4G cellular modem or wireless to the Aeroqual Cloud and the Aeroqual API. This approach enables continuous remote network management and diagnostics without any routine technical intervention in the field. In the event of unexpected sensor readings or missing data, Aeroqual and PSE staff can remotely diagnose the event by analyzing the numerous onboard sensors and coordinate further diagnostic tests by a field technician as needed.

Monitoring Areas

Where will monitoring be conducted within the community? Please include a map of monitor locations if possible.

Below is a map of the current and planned monitor locations:



[5] Aeroqual AQY v1.0 – Field Evaluation. URL: www.aqmd.gov/aq-spec/evaluations/field

What is the rationale and considerations behind the monitoring locations?

The following considerations were taken into account when choosing monitor locations:

- Community input collected through PSE's Sensor Location Suggestion Form[6]
- Known locations of significant stationary emission sources and sensitive populations[7]
- Major traffic arteries and congestion spots
- Availability of community volunteers to host air monitors

What are the characteristics of the monitoring locations (e.g., meteorology, sources, land use) and important logistical details (e.g., site access, security, power availability)?

The majority of monitoring sites are located in the Richmond-San Pablo flats and share meteorology typical of the broader San Francisco Bay Area. Several monitors are located near major industrial emissions sources such as the Chevron refinery and the Levin coal terminal. A majority of the sites are located in residential areas where vulnerable populations live. The land use characteristics of the monitoring sites are predominantly residential, as well as commercial and industrial. A small number of monitors are located in the Richmond Hills, Pt. Richmond and Pt. San Pablo for control purposes.

The monitoring locations are secure and equipped power access. PSE staff and contractors can access sites upon request in the event that field maintenance, diagnostic tests or sensor replacements are needed.

Quality Control Procedures

What quality control activities are taking place for each type of measurement, and how often do those activities take place? Quality control activities may include reference materials, calibration, ongoing quality control measures (e.g., zero point, span point, one point), blanks, spikes, duplicates/collocation, and audits.

The quality of the data collected is assured and maintained through periodic comparison of the AQY sensors with reference standards and through ongoing automated data processing and calibration. Quality control activities performed throughout the project are detailed below:

- Factory calibration prior to monitor delivery.
- Pre-deployment intra-network traditional field collocation study at a regulatory reference site for all AQY monitors to establish the baseline for inter-device variability, sensor accuracy, precision, bias, sensitivity to meteorology, drift over time, and to obtain initial field calibration parameters for all sensors. Duration: several months.
- Post-deployment intra-network traditional collocation study at a regulatory site for all AQY monitors to assess sensor degradation and sensor drift over time. Duration: several weeks.
- Continuous traditional collocation during deployment of two AQY monitors at the regulatory site in San Pablo to monitor for drift, meteorological sensitivity, and other parameters that may be transferrable to other sensors or locations in the network. Duration: continuous.

[6] https://www.psehealthyenergy.org/our-work/richmond/sensor-location-form/

[7] https://www.psehealthyenergy.org/richmond-emissions-inventory-beta/

- Ongoing quality control statistical measures based on the running probability distribution, mean, and variance of data compared to a reference "proxy" site to signal for sensor drift, zero point/sensitivity changes, or sensor failure when certain thresholds are exceeded. Duration: continuous.
- Periodic collocation of AQY monitors with reference standards for recalibration and audit purposes. Duration: periodic.

What procedures or measures are taken when quality control limits are exceeded?

A remote network-wide sensor management framework is being implemented to derive running slope and zero offset correction estimates for sensor nodes when quality control limits are exceeded, by matching the mean and standard deviations of the sensor data to values derived from a reference proxy over the same period of time. In addition, periodic collocation with a regulatory site or with another well-calibrated sensor is utilized to re-calibrate sensors, validate the remote network management approach and calibrate sites for which a reference proxy is not well defined.

Data Management

In addition to collecting the measured value of interest, what data descriptors are included (e.g., instrument identifiers, date/time stamps, units, etc.)?

Data descriptors such as instrument identifiers, site labels, date/time stamps and measurement units are included in addition to the measured values of interest.

How are data being stored? For example, are they stored in a database? Are additional attributes like data quality indicators and data qualifiers stored as well?

Data are stored on each individual instrument to ensure that no data are lost in the event of poor cellular reception. The micro PC included in each instrument can store 5+ years of data. In addition, data are automatically uploaded to the Aeroqual Cloud and the Aeroqual API, where they can be accessed and downloaded by authorized PSE staff.

What data review and flagging procedures are in place? For example, are calibrations and incomplete sample periods excluded from data aggregations?

Data review and flagging procedures include:

- Automatic data downloads for each monitor and pollutant.
- Automated generation of daily and weekly videos with data aggregated on hourly and sub-hourly timescales.
- Daily visual inspection of the data and the videos, as well as daily and weekly review of data at the sub-hourly level.
- Continuous quality control statistical measures based on the running probability distribution, mean, and variance of data compared to a reference "proxy" site to flag sensor drift or sensor failure.

Work Plan for Field Measurements

What field procedures and materials are being used to conduct monitoring?

Aeroqual AQY monitors are designed to automatically collect and communicate the data via 4G cellular modem or wireless to the Aeroqual Cloud and the Aeroqual API. This approach enables continuous remote network management and diagnostics without any routine field procedures. In the event of unexpected sensor readings or missing data, Aeroqual and PSE staff can remotely diagnose the event by analyzing the numerous onboard sensors and coordinate further diagnostic tests by a field technician as needed.

Please provide a timeline for air monitoring duration, frequency, and milestones.

Data collection is ongoing. Data are collected and reported every minute and will continue to be collected for a period of at least a year between 2020-2021.

Evaluating Effectiveness

What process is being used to ensure that air monitoring objectives are being met? How often are those evaluations conducted? How are effectiveness issues documented and addressed?

The air monitoring objectives included in this document are also featured in the grant agreement providing funding for this project (2018-2019 Assembly Bill 617 Community Air Grant funding through the California Air Resources Board). Per the grant agreement, PSE is documenting and addressing air monitoring objectives throughout the duration of the grant and will produce a final report summarizing completion of project tasks, outlining any obstacles faced and how these challenges were addressed.

What is the end point for air monitoring with this project?

This air monitoring project is supported by 2018-2019 AB 617 funding through Q1 2021. However, air monitoring efforts may continue beyond Q1 2021 pending additional funding and resources.

Analyze and Interpret Data

What is the overall approach for preparing, analyzing and interpreting data to address project objectives?

Interpreting the air monitoring data correctly and presenting our results to the wider Richmond-San Pablo community is critical to successfully achieving the objectives of this project. We plan to analyze and visualize the data through graphs of pollutant concentrations over time to show daily, weakly, seasonal and yearly concentrations; charts with wind direction to identify sources of pollution; maps showing data from the entire network to illustrate spatial patterns in pollutant concentrations; comparisons of aggregated data between individual monitoring sites; comparisons with meteorological measurements; and others.

Communicate Results

How frequently and in what format (e.g., factsheets, reports, meetings) will information be shared with the community throughout the air monitoring process?

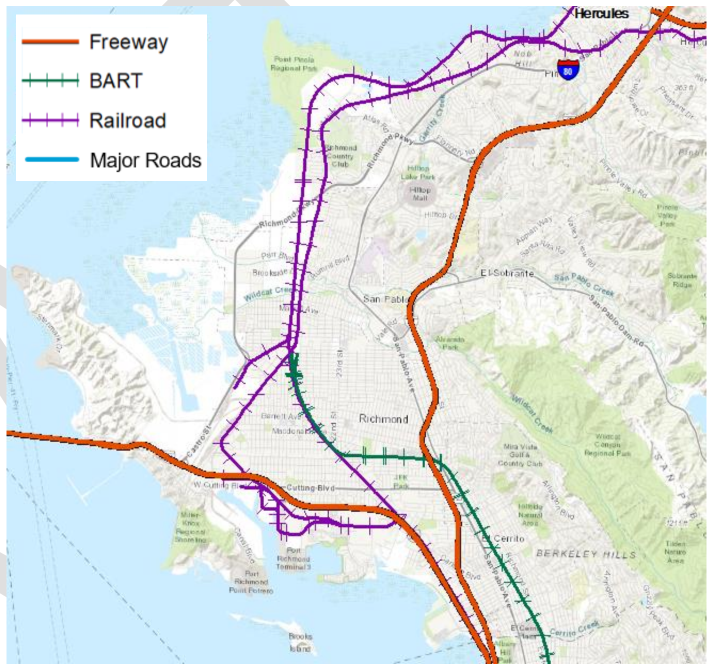
Preliminary data from initial collocation efforts and preliminary field data have been and will be shared during Richmond-San Pablo Community Air Monitoring Steering Committee meetings. Additional updates will be provided to the Richmond-San Pablo Community Emissions Reduction Plan Steering Committee throughout 2020 and 2021. Additional community outreach is anticipated with the Asian Pacific Environmental Network by the completion of the grant period (Q1 2021). Data are and will be presented at in-person and remote meetings using PowerPoint slide decks, summary documents, blogposts, and a final technical report.

APPENDIX F: OPTIONS PRESENTED FOR ADDITIONAL MONITORING PROJECTS

Monitoring Project Option #1: $PM_{2.5}$ Hotspots from Traffic

The Steering Committee identified several questions and air quality concerns related to traffic in the Richmond-San Pablo area, including:

- What is air quality like in neighborhoods along I-80 and I-580 compared to neighborhoods farther from the freeways?
- What are pollution levels on streets adjacent to schools, senior centers, or other locations with vulnerable populations?
- What impact do diesel trucks have on air quality through neighborhoods and near vulnerable populations?
- What impact do traffic backups, such as freeway onramps or at blocked railroad crossings, have on neighborhood air quality?



Freeways, major roads, and railways in the Richmond-San Pablo area.

An air monitoring project that uses multiple measurement methodologies to locate and evaluate hotspots in particulate matter (PM) can help provide data that inform the questions described above. PM measurements for this project would focus on $PM_{2.5}$ (particulate matter with diameter of 2.5 micrometers or less), since fuel combustion is a key source of these smaller particles, which also have significant health impacts. The initial monitoring efforts are providing data that can help identify $PM_{2.5}$ hotspots across the Richmond-San Pablo area. Additional monitoring may be needed to help inform more specific questions about those hotspots, such as their frequency, or contribution from diesel trucks or other specific sources. Those additional measurements may include black carbon or other particle properties like particle size, shape, and chemical makeup.

Potential Monitoring Objectives

- Locate and better understand $PM_{2.5}$ hotspots near roadways
- Determine if $PM_{2.5}$ hotspots are near schools, childcare centers, senior centers, recreational areas, or other outdoor locations where people gather
- Compare air quality in neighborhoods near freeways to neighborhoods farther away
- Evaluate $PM_{2.5}$ characteristics to help determine the amount of the total $PM_{2.5}$ levels coming from diesel combustion or other specific sources

Desired Actions

- Use knowledge of areas or times of $PM_{2.5}$ hotspots to support health-based decision making

- Use results to inform and prioritize strategies to reduce emissions and exposure around identified $PM_{2.5}$ hotspots, particularly those near vulnerable populations

Measurement Approaches and Instrumentation

- Mobile air monitoring using the Air District van to drive through communities to measure $PM_{2.5}$, black carbon (BC), and other particle properties or gases that help differentiate various sources.
- Monitoring at a specific location for multiple hours or days using filter-based sample collection and other instruments not suited to mobile monitoring. For example, in addition to measuring $PM_{2.5}$ levels and BC, PM samples could be collected on filters for other chemical analysis, and PM levels could be tracked for changes from day to day throughout the study, which could help identify the contributing sources in complicated areas.
- Meteorological measurements (wind speed and direction, temperature, humidity)

Considerations and Expected Challenges

- There are many sources of PM in the Richmond-San Pablo area in addition to traffic, such as industrial operations and residential wood smoke. PM measured in Richmond-San Pablo is expected to be a combination of local emissions and pollution transported into the community.
- Robustly characterizing hotspots that are not clearly attributable to traffic may require monitoring for up to a year. However, if impact is quickly apparent and appropriate weather conditions occur, preliminary data could be informative in three months.
- Weather conditions, such as wind direction and precipitation, may not be conducive for short-term studies, possibly requiring additional time to collect sufficient measurement data.
- Logistical considerations such as availability and access to possible monitoring locations, should portable or short-term stationary measurements be needed.

Project Phases

PHASE 0: Project planning and evaluating existing monitoring data (approximately 1-3 months)

- Define specific data objectives needed to inform health-based decision-making efforts and strategize traffic emissions reduction efforts
- Gather and evaluate existing non-measurement data sets, such as traffic and modeling data
- Evaluate PM data from existing air monitoring networks or projects, including from the three initial monitoring projects, to identify areas/times with higher than average PM near roadways
- If possible, use those existing data to determine the likely source(s) of those PM hotspots
- Design detailed plan for measurements for remaining hotspot areas that need more information. This plan includes timeline, location and duration of monitoring, instrumentation, analysis methods, quality assurance and quality control measures, data reporting and intended data uses.

PHASE 1: Follow-up measurements (approximately 3-12 months)

Use the Air District van, portable samplers, and/or short-term monitoring platforms to collect information on PM physical and chemical characteristics, black carbon and ultrafine particle levels, meteorological conditions, and data on other pollutants to:

a. Help characterize hotspots that are not well understood after evaluating data from existing monitoring projects, as this characterization may require measurement methodologies that were not part of those existing projects
b. Help characterize hotspots identified near sensitive or vulnerable populations
c. Distinguish between gasoline and diesel combustion
d. Evaluate specific sources or areas of concern as directed by the Steering Committee

Monitoring Project Option #2: PM Impacts from Coal and Petroleum Coke Operations

The Steering Committee identified questions and air quality concerns around coal and petroleum coke operations in the Richmond-San Pablo area, including:

- What impact do Levin Terminal and related coal and petroleum coke operations have on local air quality? Some specific concerns at the terminal include loading and unloading operations, windblown dust from coal and petroleum coke piles, and marine operations.
- Can coal and/or petroleum coke dust be detected in the air along railways that transport these materials to the terminal?

Map of the area around Levin Terminal, including adjacent rail lines and shipping waterways. Numerous other potential sources of PM are also located in this area. The exact monitoring project study area will be defined as the project plan is developed.

The air monitoring project outlined below uses multiple measurement methodologies to help inform these concerns by evaluating the impact that coal and petroleum coke operations have on particulate matter (PM). PM related to coal and petroleum dust is expected to have certain chemical and physical properties, such as its elemental makeup and particle size distribution. Monitoring the PM using the Air District van and short-term sites can help provide information on those properties.

Monitoring Objective

Quantify the contribution of coal and petroleum coke dust emissions from trains transporting these materials and from Levin Terminal operations on ambient PM concentrations near those activities.

Desired Action

Inform development and implementation of PM emissions reduction efforts on coal and petroleum coke operations.

Measurement Approaches and Instrumentation

- Mobile air monitoring using the Air District van to drive through communities to measure $PM_{2.5}$, black carbon (BC), and other particle properties or gases that help differentiate various sources.
- Monitoring at a specific location for multiple hours or days using filter-based sample collection and other instruments not suited to mobile monitoring. For example, in addition to measuring $PM_{2.5}$ levels and BC, PM samples could be collected on filters for other chemical analyses, and PM levels could be tracked for changes from day to day throughout the study.
- Meteorological conditions (wind speed and direction, temperature, humidity) associated with air quality measurements

Considerations and Expected Challenges

- Robustly characterizing PM impacts from coal and petroleum coke operations may require monitoring for up to a year. However, preliminary data could be informative in three months depending on conditions during the study time.

- There are many sources of PM in the area including: coal and petroleum terminal and operations, metal recycling facility, aggregate facilities, tank terminals, a cement plant, a gypsum facility, a wastewater plant, traffic (including I-580 and I-80), rail operations, other port and shipping operations, and housing construction.
- Discerning between coal and petroleum coke dust, and between fresh fugitive coal and petroleum coke dust emissions and re-suspended dust from historical emissions, are challenging objectives, and methodologies to do so are not well proven and come with increased data uncertainty.
- Weather conditions, such as wind direction and precipitation, may not be conducive for short-term studies, possibly requiring additional time to collect sufficient measurement data.
- Logistical considerations such as availability and access to possible monitoring locations.

Project Phases

PHASE 0: Project planning (approximately 1-2 months)

- Define a study area and specific data objectives needed to inform development and implementation of emissions reduction efforts on coal and petroleum coke operations
- Evaluate potential PM emission sources in the study area and chemical and physical properties of those PM emissions
- Design a detailed plan for PM measurements related to coal and petroleum coke operations that includes a project timeline, locations and duration of monitoring, instrumentation, monitoring and analysis methods, quality assurance and quality control measures, data reporting and intended data uses

PHASE 1: Screen for detailed PM information (approximately 3-6 months)

- Mobile measurements using the Air District's mobile van will take place throughout the defined study area. When possible, data will be collected during a mix of meteorological conditions, and upwind and downwind of facilities, to provide information about air pollutants coming from a specific facility or characterize the local background concentration of pollutants.
- Areas of higher concentrations, either identified by Air District mobile monitoring or by the initial monitoring efforts will be investigated further by making repeat monitoring passes. Short-duration (on the order of minutes) stationary monitoring by the mobile lab may be employed to check intermittence of high concentrations and collect meteorology data at the location.
- Measure physical and chemical characteristics of PM coal and petroleum coke dust through other types of sample analyses, source testing, or materials testing.

PHASE 2: Verification and short-term trends of PM (approximately 3-12 months)

- Measurements using portable monitors and/or short-term monitoring platforms may collect samples over longer periods of time at areas of high PM concentration identified in Phase 1 to provide additional information that can help characterize coal contribution to PM, such as how the levels change through time. Further analyses of the collected samples could also identify specific elements or compounds in the PM and other physical properties that could help distinguish between contributing sources.
- Portable monitors may be deployed at locations upwind of facilities to provide information on local background of pollutants, or in areas of low pollutant concentration identified in Phase 1 to evaluate potential differences in pollutant speciation and investigate whether low concentrations continue over time.

Monitoring Project Option #3: Identify Air Toxics Hotspots

The Steering Committee identified several air quality questions and concerns related to stationary pollution sources in the Richmond-San Pablo area, including:

- What are pollution levels in neighborhoods adjacent to large industrial facilities? Some example large facilities include Chevron and refinery-related operations, waste and water management facilities, and metal scrapyards.
- Where are pollution levels unusually high, especially near vulnerable populations or where people spend time outdoors, and what sources contribute to those pollution hotspots?
- What impact do certain small businesses have on neighborhood air quality, such as auto body shops, restaurants, gas stations, and dry cleaners?
- What sources are odors coming from and what pollutants are associated with them?

An air monitoring project using multiple measurement technologies to identify and better understand areas with higher levels of air toxics can help inform the concerns described above. Air toxics are a group of pollutants that may cause serious health effects. This monitoring project would focus on gaseous air toxics, such as the gases listed on CARB's Toxic Air Contaminant[a] page. Air toxics can be emitted by a wide range of sources and operations[b], many of which exist in the Richmond-San Pablo area and were identified by the Steering Committee. Currently, some refinery-related air toxics are measured along the Chevron fenceline with three open-path monitors and at three community monitoring stations[c]. In addition, the Air District operates two monitors in Richmond-San Pablo designed to assess longer-term trends in air toxics. These existing monitors do not provide the hyperlocal air toxics data that would be needed to help identify hotspots and inform air quality concerns highlighted by the Steering Committee.

Potential Monitoring Objectives

- Identify where air toxics levels are unusually high and determine if those hotspots are near schools, childcare centers, senior centers, and recreational areas.
- Evaluate air toxics levels around facilities identified and prioritized by the Steering Committee. This may include facilities like wastewater treatment plants, landfills, metal facilities, refinery operations, or small businesses like auto body shops, restaurants, dry cleaners, and gas stations.
- Identify sources and pollutants associated with odors.

Desired Actions

- Identify and implement measures to reduce emissions that contribute to identified hotspots
- Develop additional emissions reductions actions

Measurement Approaches and Instrumentation

- Mobile air monitoring using the Air District van to drive through communities and near facilities to measure levels of air toxics. The Air District monitoring van can detect low levels of hundreds of different gaseous air toxics at one-second frequency.
- Monitoring air toxics at a specific location for multiple hours or days using the van or canister sampling with subsequent chemical analyses to track changes from day to day throughout the study, to help identify the contributing sources in complicated areas.
- Meteorological conditions (wind speed and direction, temperature, humidity)

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[a] CARB's Toxic Air Contaminant website: https://ww3.arb.ca.gov/toxics/id/summary/summary.htm

[b] EPA's Air Toxics websites: https://www.epa.gov/haps; https://www.epa.gov/urban-air-toxics/area-sources-urban-air-toxics

[c] Chevron fenceline monitoring data: https://www.richmondairmonitoring.org/measurements.html

Considerations and Expected Challenges

- There are many potential and overlapping sources of air toxics in the Richmond-San Pablo area, which may complicate the identification of individual sources.
- Some air toxics hotspots may be short in duration and/or frequency, making them more difficult to characterize and trace.
- Weather conditions, such as wind direction and precipitation, may not be conducive for short-term studies, possibly requiring additional time to collect sufficient measurement data.
- Logistical considerations such as access to possible monitoring locations, should portable or short-term stationary measurements be needed.

Project Phases

PHASE 0: Project planning (approximately 1-2 months)

- Define specific monitoring objectives needed to inform emissions reduction efforts, including specific measurement area or facilities
- Gather updated air toxics emissions inventory data for the facilities in the study area
- Design detailed measurement plan for air toxics hotspots that includes selected monitoring objectives, timeline, location and duration of monitoring, instrumentation, analysis methods, quality assurance and quality control measures, data reporting and intended data uses

PHASE 1: Hotspot screening measurements (approximately 3-6 months)

- Measure gaseous air toxics throughout the study area using the Air District's mobile van
- Analyze those data to locate hotspots and evaluate potential sources
- Determine if identified hotspots are near schools, childcare centers, senior centers, recreational areas, or other locations where people gather
- Refer identified hotspots to Air District enforcement when applicable to an emissions limit

PHASE 2: Follow-up measurements (approximately 3-12 months)

- Understanding some hotspots may require data over longer periods of time to understand the variability of the issue or more specific pollutant information from analysis methods that are not feasible using the Air District's mobile van. Portable samplers and/or short-term monitoring platforms may be deployed to obtain additional measurements
- Instrumentation and duration for follow-up measurements will be determined based on what variability and/or source contribution is being investigated

Defining a Study Area

The Steering Committee will define the study area for this project. Study areas could include communities where there are several large industrial sources near residential areas, such as North Richmond, the Iron Triangle, and around Richmond Harbor. While there are many uncertainties, the Air District expects initial monitoring of one area to take approximately two months. This project may be able to cover more than one area depending on how quickly results are achievable.

Ideas for additional monitoring areas for identifying air toxics hotspots

APPENDIX G: AIR TOXICS MONITORING PROJECT INFORMATION

Project organizers: Bay Area Air Quality Management District (Air District)

Define Air Monitoring Objectives

What are the objectives of this air monitoring project?

The Steering Committee identified air quality concerns across Richmond-San Pablo through a series of mapping activities and discussions. These concerns were wide-ranging, including specific large and small stationary sources and mobile sources such as freeways, railways, and shipping. The air toxics monitoring project is designed to be flexible in terms of pollutants and areas for measurements in order to accommodate multiple air quality concerns. Some objectives for this project include:

- Screen for common gas-phase air toxics within the study area to identify locations/areas where levels are unusually high compared to surrounding areas
    - Determine if areas with high concentrations are near places with vulnerable populations, such as schools, childcare centers, senior centers, and recreational areas to help inform exposure reduction efforts
    - Characterize areas with high concentrations to help identify possible sources and inform emissions reduction and/or enforcement efforts
- Evaluate air toxics levels around specific facilities identified and prioritized by the Steering Committee, such as wastewater treatment plants, landfills, and refinery operations, and small businesses such as auto body shops, restaurants, dry cleaners, and gas stations
- Identify sources and pollutants associated with odors

What will be measured, when and where will it be measured, and why?

This air toxics monitoring project will focus on volatile organic compounds (VOCs). VOCs represent hundreds of individual organic compounds. There are many known and potential sources of VOCs in the Richmond-San Pablo area. This project will begin with screening monitoring for common air toxics (using existing information on emissions permitted facilities in order to focus on specific VOC's initially) across a large area in Richmond-San Pablo from roughly Richmond Pkwy on the west to 23rd Street on the east. This corridor contains numerous known and potential sources of VOCs per emissions inventory information and includes many of the areas or sources of concern identified by the Steering Committee.

These screening measurements will be made using the Air District's air monitoring van, which has state-of-the-art instrumentation with the capacity to measure VOCs at higher spatial and time resolution than previously available at the Air District. Some common air toxics such as benzene, toluene, ethylbenzene, and xylene (BTEX) will be measured across this area as they can be produced by a wide range of sources, including refinery and petroleum-related operations, and combustion from stationary and mobile sources (See Table G3 in Monitoring Methods & Equipment section). Other VOCs or pollutants can also be targeted for measurement if they are known or suspected to be emitted by a particular source.

Measurements from the air monitoring van will generally provide a snapshot in time of pollutant concentrations, and therefore are more likely to identify persistent or frequent issues. When concentrations are measured at levels much higher than in surrounding areas, additional measurements may be used to help understand and characterize the source(s) of the high concentrations. These additional measurements could include operating the van in one fixed location over several minutes up to about an hour, or portable or fixed-site short-term monitors or samplers at one location, providing either continuous and/or time-integrated measurements to help capture daily variations or patterns in pollutant concentrations through time. Meteorological data such as wind speed and wind direction may also be collected at fixed locations to help understand areas of high pollutant concentrations and evaluate potential pollution sources.

The Air District hopes to begin the screening measurements by the end of Summer 2020, though this timeline may be affected by the ongoing shelter-in-place restrictions due to COVID-19. Screening measurements and additional monitoring to better understand areas of high pollutant concentrations are then expected to continue for at least several months to produce a robust data set that can inform emissions and exposure reductions efforts. More information on the frequency and schedule for mobile monitoring that will be used to produce this data set can be found in the Work Plan for Field Measurements section later in this Appendix. The Air District will work with the Monitoring Outreach Team to prepare and share updates on monitoring progress, data collected, and findings routinely with members of the Monitoring Plan Steering Committee, Technical Advisory Group, CERP Steering Committee, and the public. Updates will also be posted on the Air District's website.

Roles and Responsibilities

What parties are responsible for major aspects or phases of air monitoring? What are the roles of these parties?

The Air District's Meteorology and Measurements division will be primarily responsible for this project. Within the Air District's Meteorology and Measurements division, the Ambient Air Quality Analysis (AAQA) group and Air Monitoring Special Projects (AMSP) group will plan the project, and the AMSP group will conduct the data collection and data quality control and assurance. The AAQA and AMSP groups and the Air District's Technical Assessment Team will perform the data analysis and reporting tasks. The Technical Assessment Team is made up of staff from the Meteorology and Measurements division and the Assessment, Inventory, and Modeling division, and will be primarily responsible for using data and analyses from this project to help inform emissions and exposure reductions efforts. The Technical Assessment Team will work directly with the Monitoring Outreach Team to include community perspective and insight in developing and presenting monitoring updates and reports.

What are the training requirements for individuals conducting air monitoring?

All air monitoring activities, including daily operation, maintenance, routine quality control checks, and data review will be performed by three trained Air Quality Instrument Specialists (AQIS) and will be supervised by the Supervising AQIS. Technical operations will be overseen by the Principal AQIS. Calibrations and more technically complicated quality control activities, such as calibrating gaseous analyzer calibrators, will be performed by the Senior AQIS.

AMSP staff are largely cross-trained at monitoring stations across the Air District's regulatory fixed-site network, however, much of the AMSP instrumentation differs from the regulatory network instrumentation and so requires additional training. Upon receiving new instrumentation, all staff read relevant manuals and standard operating procedures (SOPs). AQIS at all levels contribute to development, review, and routine updates of all AMSP SOPs. When available, staff are trained by the manufacturer on instrument operation, maintenance, and troubleshooting. AMSP staff will receive training from EPA, CARB, California Air Pollution Control Officers Association (CAPCOA), and other resources when offered.

Current staff completed three-week hands-on rotational periods, supported by the Supervising and Principal AQIS, to familiarize themselves with two new instruments per period, including performing manufacturer's recommended maintenance, quality control activities, acceptance testing, and calibration when appropriate, as well as designing and performing a small "study" to practice routine operation. After the initial three-week period, a "Round-Robin" training approach was employed and each staff member learned, and subsequently taught, theory and operation of relevant AMSP instrumentation. For new staff, Supervising, Principal, and Senior AQIS will design and implement a hands-on training program that is comprehensive and fits within the air monitoring van's operational schedule.

In addition to technical training, the AMSP team underwent a multi-day equity training following the principles of the Government Alliance on Race and Equity (GARE) taught by two trained GARE members from the AMSP team. This training was timed to precede the Richmond-San Pablo AB617 Community Summit in November 2019, which was attended by the entire AMSP team. The training included foundational lessons on government's role in promoting racial equity, as presented by GARE, and a cultural history of the racially diverse Richmond-San Pablo area. The Meteorology and Measurement Division continues to seek out opportunities for racial equity and environmental justice trainings.

Define Data Quality Objectives

Data quality attributes for project instrumentation and methodologies are provided below.

What are the performance and acceptance criteria for collected data?

Measurement quality objectives (MQO's) are used to assess the performance of instrumentation and acceptance criteria for the data collected to determine whether they meet the project DQO's. These MQO's are evaluated as data are collected, as well as in post hoc Level 1 data review to determine validity of the measurements. Table G1 below lists the MQO's and their corresponding performance and acceptance criteria. MQO's listed in Table G1 are as outlined in Appendix D of EPA's QA Handbook Volume II[1]. These MQO's are adopted when appropriate and are designed to meet or exceed the requirements of Title 40, Part 58, Appendix A of the Code of Federal Regulations, and are referenced in the AMSP Quality Assurance Project Plan (QAPP). Pending finalization, the AMSP QAPP can be made available upon request by email to AB617info@baaqmd.gov. Data Quality Indicators (DQI) are presented as supporting comments and flags in the dataset that indicate whether the data may be used to support the analysis tied to the monitoring goal. Typically, these will highlight data that are valid for this purpose or not, and if not some indication as to why the data are determined not fit for their purpose.

What criteria are being used for precision, bias, accuracy, sensitivity, and data completeness?

Per EPA guidance[2] the term accuracy is not used as it represents both precision and bias measurements. No formal method for sensitivity is specified, therefore lower detection limits (LDL) are provided.

[1] EPA's QA Handbook Volume II:
https://www3.epa.gov/ttn/amtic/files/ambient/pm25/qa/APP_D%20validation%20template%20version%2003_2017_for%20AMTIC%20Rev_1.pdf

[2] EPA Guidance on meaning and use of precision and bias data:
https://www3.epa.gov/ttnamti1/files/ambient/monitorstrat/precursor/07workshopmeaning.pdf

Table G1. Parameters and measurement quality objectives (MQOs)

Monitor Type	Requirement	Measurement Quality Objective
Carbon Monoxide	Precision (standard deviation): Bias (% difference): Sensitivity (LDL): Completeness:	≤± 2.1% ≤± 2.1% 15 ppb 85%
Carbon Dioxide	Precision (standard deviation): Bias (% difference): Sensitivity (LDL): Completeness:	≤± 2.1% ≤± 2.1% 50 ppb 85%
Nitrogen oxides	Precision (standard deviation): Bias (% difference): Sensitivity (LDL): Completeness:	≤± 2.1% ≤± 2.1% 1 ppb 85%
Methane	Precision (standard deviation): Bias (% difference): Sensitivity (LDL): Completeness:	≤± 2.1% ≤± 2.1% 1 ppb 85%
Speciated VOC's	Precision (standard deviation): Bias (% difference): Sensitivity (LDL): Completeness:	VOC dependent VOC dependent > 2500 cps/ppb 85%
Particle size (5.6 nm – 560nm)	Precision (standard deviation): Bias (% difference): Sensitivity (LDL): Completeness:	Particle size dependent Particle size dependent 5.6 nm 85%
Particle count (5.6nm – 560nm)	Precision (standard deviation): Bias (% difference): Sensitivity (LDL): Completeness:	Particle size dependent Particle size dependent 1 #/cm^3 85%
Particle size (0.3µm -10µm)	Precision (standard deviation): Bias (% difference): Sensitivity (LDL): Completeness:	Particle size dependent Particle size dependent 0.3 µm 85%
Particle count (0.3µm -10µm)	Precision (standard deviation): Bias (% difference): Sensitivity (LDL): Completeness:	Particle size dependent Particle size dependent 0.3 µm 85%
Black carbon	Precision (standard deviation): Bias (% difference): Sensitivity (@ 1 min time-base): Completeness:	Time-base dependent Time-base dependent 0.03 µg/m3 85%
Wind speed	Precision (standard deviation): Bias (% difference): Sensitivity (LDL): Completeness:	Not applicable Not applicable 0.1 m/s 85%
Wind direction	Precision (standard deviation): Bias (% difference): Sensitivity (LDL): Completeness:	Not applicable Not applicable 1° 85%

What is the temporal and spatial representativeness of the monitoring?

For mobile monitoring, temporal and spatial representativeness of the testing will be ensured through development of pre-determined random driving routes through the defined project area. These randomized routes will be used to make certain the air monitoring van obtains air quality data throughout this region at different times of day and days per week, thereby minimizing any biases associated with temporal source emission patterns. Data collected during times when the air monitoring van is kept stationary (e.g., to verify an air pollution hot spot) will be flagged to differentiate it from data collected while in motion. When pollution signals of interest appear, deviations from the pre-determined route may occur. Data from these route deviations will also be flagged in the data management system and their inclusion in larger analysis will be determined on a case-by-case basis. It is recognized that possible limitations will result from lack of evening and weekend data collection.

For follow-up sample collection, representativeness will be tied to the purpose of the specific deployment. If appropriate, upwind and downwind sites may be selected for temporary short-term or portable monitors to provide information on spatial representativeness of samples. Collection times will be selected to provide the average concentration over the desired time interval and runs can be scheduled to target a specific time of day or day of week. Samples may be one-off or set up for routine collection (e.g., one 24-hr sample collected every six days) as may be determined from downstream data needs.

Monitoring Methods and Equipment

What monitoring methods and equipment are being used? Include instrument make, model, and characteristics.

The Air District’s air monitoring van is equipped with instrumentation to measure gaseous pollutants such as NO_x, CH_4, CO, CO_2, and a range of VOCs; particulate matter mass and physical characteristics, including black carbon concentration and speciated particle size from 5 nm to 10 µm across 45 size bins; meteorological measures including temperature, pressure, wind speed and direction, and solar irradiance; and location data via global positioning system (GPS). More information on the instrumentation onboard and parameters measured by the air monitoring van can be found in Table G2. All air quality data collected are timestamped and location synchronized with GPS. The air monitoring van can also collect whole air instantaneous or grab samples for analytical analyses as needed.

The air monitoring van will be used to screen for and help characterize the spatial distribution of VOC concentrations within the study area. The collected data are intended to be used to help identify locations with particularly high levels of VOCs relative to normal urban background levels. Additional measurements using either the air monitoring van and/or other monitoring capabilities such as portable or short-term sites may be used to help better understand those areas with particularly high levels of VOCs. In some cases, the air monitoring van itself may serve as a very short-term stationary station to better understand variations in VOC levels at a location on the order of minutes to up to about an hour. While the objectives of this project are centered around gas-phase air toxics, the air monitoring van can also simultaneously measure other gases and particulate matter. These additional data sets may be used along with other existing measurement or emissions data to aid with source identification and characterization and may be evaluated for other questions in subsequent analyses.

Table G2. Air Monitoring Van Instrumentation and Parameters Measured

Parameter	Analyzer	Measurement Method	Frequency	Reporting Interval
NO_x	Thermo Scientific 42C	Chemiluminescence	1 s	1 s
CH_4, CO, CO_2	Picarro G2401	Cavity Ringdown	1 s	1 s
VOCs	Ionicon PTR-tof-MS 6000 X2	Proton transfer reaction time of flight mass spectrometry	1 s	1 s
Particulate Matter Mass/Number Concentration 0.3 - 10 µm (16 bins)	TSI Optical Particle Spectrometer (OPS) 3330	Optical light scattering	1 s	1 s
Particulate Matter Number Concentration 5 – 560 nm (32 bins)	TSI Fast Mobility Particle Sizer (FMPS) 3091	Electrical mobility analyzer with electrometer particle detector	1 s	1 s
Black Carbon Concentration	Magee AE33	Optical absorption	1 s	1 s
Temperature, Pressure, & RH	Columbia Magellan MX 501	Internal solid-state sensor	1 s	1 s
Wind Speed & Direction	Columbia Magellan MX 501	Sonic anemometer	1 s	1 s
Solar Irradiance	Columbia Magellan MX 501	Solar Radiation Sensor/Pyranometer	1 s	1 s
Global Positioning System	Columbia Magellan MX 501	GPS antenna receiver	1 s	1 s

In addition to the monitoring van, portable samplers or continuous monitors may be employed to gather short-term, stationary data. Portable monitors may include a range of smaller, low power instruments, several of which can be contained in an in-house-developed, secure, weather-proof enclosure equipped with a shore power line, a data logger, and cellular network communications. Instruments may include: microAeth MA300 (AethLabs), Optical Particle Sizer 3330 (TSI), MiniVol Portable Air Sampler (Airmetrics), Model 901 Canister Sampler (Xonteck), Model 405 nm NO_x Monitor (2B Technologies), or Model 202 nm O_3 Monitor (2B Technologies). Table G3 below provides a list of possible VOCs of interest during our monitoring of the Richmond-San Pablo area. The full list of VOCs monitored will be informed by initial screening studies during which time, Air District staff will identify the full suite of VOCs to be measured.

Table G3. Table of possible VOCs of interest during Richmond-San Pablo Study.

VOC	
Benzene	Trimethylbenzene
1,3- Butadiene	Ethylene oxide
Styrene	Benzo[a]pyrene
Toluene	Acetaldehyde
Xylene's (mixed)	Ethylbenzene

Explain how these monitoring methods and equipment are suitable to meet monitoring objectives.

As described previously, the Richmond-San Pablo area encompasses a large geographic area and contains a diverse range of pollution sources and geographic features. These factors present considerable challenges to studying and understanding community-level air quality. The Air District's air monitoring van offers the opportunity to collect real-time measurements for multiple pollutants at a hyperlocal level, and over a much larger area than would be feasible using conventional monitoring techniques. VOCs are the focus of this monitoring project and are emitted by a wide variety of sources, and many of those potential sources were identified as air quality concerns by the Steering Committee. The PTR-MS on-board the air monitoring van is the appropriate instrumentation for this project as it can measure concentrations of many VOCs simultaneously in near-real-time. This project also collects data and information for pollutants that are not covered by the other projects in this air monitoring plan. Depending on the data collected during the mobile exploratory monitoring, additional measurements may be needed to help understand air quality issues in locations where high pollution levels are found. Those additional measurements may be taken through a range of methods depending on what kinds of data are needed. For example, fixed-site, short-term monitoring at a location would be better suited for collecting data over days, weeks, or months, should information on temporal variations in pollution or pollution trends be needed.

Include or describe the field and/or laboratory Standard Operating Procedures that will be followed.

All instruments operated in the Air District's air monitoring van have AMSP-developed Standard Operating Procedures (SOPs) outlining the details of operation, quality control procedures and schedules, quality assurance thresholds, maintenance procedures and schedules, troubleshooting, theory of operation, set up, and data logging configuration. All SOPs are developed using manufacturer documentation, such as operational manuals, as well as lessons learned during acceptance testing and training on new instrumentation. SOPs will be followed for all instruments in the air monitoring van, in addition to in-house developed environmental sensor nodes for controlling and tracking environmental indicators in the van such as temperature, flow rate, and pressure. SOPs will also be followed for overall operation of and data review procedures for the air monitoring van. A Richmond-San Pablo "mission" SOP will detail any specifics of the field study that are not described elsewhere in general SOPs such as mission deployment schedule and route. Sample analyses may be performed at the Air District Laboratory or other certified labs using applicable analytical techniques and methods.

Monitoring Areas

Where will monitoring be conducted within the community? Please include a map if possible.

Exploratory screening measurements for VOCs using the Air District's air monitoring van will take place roughly within the Richmond Parkway to 23rd Street corridor (Figure G1). Locations for additional monitoring to better understand areas of high pollutant levels, potentially using portable and/or fixed-site short-term monitors, will be determined as needed based on the exploratory screening data.

What is the rationale and considerations behind the monitoring locations?

This area contains numerous known or potential sources of air toxics and sources of concern identified by the Steering Committee, as well as adjacent neighborhoods, allowing for the potential to gather data across a range of land uses and places where people live, work, and spend time. While use of mobile monitoring can greatly expand the geographic area in which we can collect data compared to using conventional stationary monitoring capabilities, it is not logistically feasible to robustly conduct these measurements across the entire Richmond-San Pablo area and perform subsequent analyses given Air District constraints on staff and equipment resources. Thus, the identified area represents a balance between collection and analysis of a data set that can robustly inform multiple monitoring objectives with current monitoring resources and capabilities.

Figure G1. Monitoring area in Richmond-San Pablo for air toxics exploratory screening measurements.

What are the characteristics of the monitoring locations (e.g., meteorology, sources, land use) and important logistical details (e.g., site access, security, power availability)?

It is anticipated that the air monitoring van will be able to collect data from any publicly accessible location in the study area. Stationary monitoring using the air monitoring van with durations longer than about an hour require shore power. Issues related to site access, security, and power availability will be addressed when locations for portable and/or short-term fixed-site monitoring are identified, should those monitoring capabilities be needed.

Quality Control Procedures

What quality control activities are taking place for each type of measurement, and how often do those activities take place? QC activities may include reference materials, calibration, ongoing quality control measures (e.g., zero point, span point, one point), blanks, spikes, duplicates/collocation, and audits.

Instrument and air monitoring van components critical to sample collection will undergo thorough routine QC checks as outlined by QC and maintenance schedules in the instrument SOP's and AMSP QAPP, where QC check levels and acceptance criteria also reside. These checks will be documented using standardized Excel-based QC sheets and the results of QC checks will be automatically logged to a protected database. Monitoring QC results over time will allow for consistent evaluation and tracking of instrument performance. Specific QC checks by parameter are in Table G4. Pre- and post-mission co-location for $PM_{2.5}$ and black carbon along with meteorological data will be performed at one of the Air District's fixed sites. If an instrument does not meet MQOs or fails a QC check, associated data dated back to the last passing check will be flagged as 'suspect' and investigated for validity. Repairs and maintenance will be performed on the instrument before it is used for further data collection. Such repairs will first be attempted in the field and if unsuccessful the instrument will be brought back to the AMSP laboratory. If an instrument is out of service for an extended period of time, monitoring will continue with instruments that are operating properly, but data will not be collected for the malfunctioning instrument, which will be returned to service as quickly as possible.

Table G4. Parameters and QC Check Information

Parameter	Minimum Frequency
Carbon Monoxide	QC check Weekly; annual (or as needed) calibration
Carbon Dioxide	QC check Weekly; annual (or as needed) calibration
Nitrogen Oxides	QC check Weekly; annual (or as needed) calibration
Methane	QC check Weekly; annual (or as needed) calibration
Speciated VOC's	QC check Weekly; annual (or as needed) calibration
PM 0.0056 µm - 560 nm (size)	Monthly multi-point check, flow check
PM 0.0056 µm - 560 nm (count)	Monthly zero and span, flow check
PM 0.3 µm – 10 µm (size)	Monthly multi-point check, flow check
PM 0.3 µm – 10 µm (count)	Monthly zero and span, flow check
Black Carbon	Monthly flow check, leak check, flow ratio check, Quarterly inlet leak check, annual neutral density optical test
Wind Speed and Direction, Temperature, Pressure, and Relative Humidity	Quarterly spot-check against Air District stationary meteorology station; annual multi-day collocation check on a meteorology tower
Sampling line Temperature Controller	Monthly temperature calibration
Sampling system flow, pressure, and temp monitor	Monthly temperature, flow, and pressure calibration

What procedures or measures are taken when quality control limits are exceeded?

Instruments that exceed quality limits are brought to the AMSP laboratory where AMSP staff can troubleshoot and repair if able or send it to the manufacturer for factory repair. Upon receipt, a repaired instrument undergoes performance testing to make sure it complies with manufacturer specifications and meets all MQOs.

Data Management

In addition to collecting the measured value of interest, what data descriptors are included (e.g., instrument identifiers, date/time stamps, units, etc.)?

For each concentration measurement made or sample collected, additional parameters will be recorded including, the instrument's name and unique serial number; the date and time measurements were made or time period a sample was collected; the units of measurement; and key metadata used to assess the performance of the instrument to verify it is operating correctly. These metadata may include such measurements as flows, internal temperature, lamp voltages, pressure, raw sensor response, or others.

Additional measurements will be made to provide context for the collected concentration data, including meteorology (when possible), GPS position, and time stamp for each data point. For mobile monitoring, measurements will be made at a time interval of one second. Wherever possible, instruments will be logged on the same computer to ensure timestamps are identical across instruments. Where logging is performed off the main data acquisition system, clock checks will be performed to ensure equivalent time stamps between systems before each mission.

Collectively these data will provide the value of interest, typically concentration, and ensure our ability to tie that data directly to the instrument making the measurements, show that the instrument was operating properly, and provide the time and location each measurement was made.

How are data being stored? For example, are they stored in a database? Are additional attributes like data quality indicators and data qualifiers stored as well?

Data are stored in text-based files on the data acquisition system and backed up nightly to a network attached storage. These files may include raw output from instrumentation, parsed output from data acquisition software, log files containing field observations (e.g., visible emissions like smoke, traffic events such as passing a large truck, or general weather conditions like if its overcast or sunny), instrument QA/QC, other data quality indicators, and files containing qualified data output.

What data review and flagging procedures are in place? For example, are calibrations and incomplete sample periods excluded from data aggregations?

Data review and flagging procedures can be reviewed in the "Data Review Appendix" of the Air District's AMSP SOP entitled "Data Management System_SOP" which includes the processes used to verify data and flag any data that might be suspect. Pending their finalization, SOPs can be made available upon request by email to AB617info@baaqmd.gov. There are three ways data might be flagged before being deemed verified and ready for analysis. These include (1) auto-QC occurring in real-time as data is collected through a system that also notifies operators if metadata or concentration values exceed a given threshold, (2) manually through an onboard logging system connected to the DAS in the air monitoring van, and (3) manually during post-hoc data review and validation.

Since we expect most of our monitoring for this project to be made using the air monitoring van, there will be discrete monitoring missions for which appropriate sampling and aggregation periods will be defined. Suspect data or data deemed invalid is flagged, provided with a description of why it was flagged (if possible), and omitted from aggregations. Data is never removed from raw data files. All mission specific information will be catalogued and documented in a text-based file at the top of each project directory.

Work Plan for Field Measurements

What field procedures and materials are being used to conduct monitoring?

All monitoring work under this project will be conducted by trained staff in the Air District's Meteorology and Measurements division. Staff will adhere to established Air District SOPs on air quality monitoring and data review and validation. Specific SOPs are still being prepared for operating equipment that are new to the Air District. In those cases, staff will follow manufacturer guidelines and other existing guidance until SOPs are finalized. Finalization of all SOPs is contingent on access to the AMSP lab and air monitoring van after being sheltered in place, which is expected to happen the first week of August 2020. Contact AB617info@baaqmd.gov for the most recent versions of SOPs in question. The following list of SOPs are currently awaiting finalization:

- 2B_202_O_3 SOP
- 2B_405_NO_x_SOP
- Airmar_200WX_SOP
- AethLabs_MA300_SOP
- Data Management System_SOP
- Environics 9100_SOP
- Ionicon_PTR_tof_MS_SOP
- Magee_AE33_SOP
- Picarro_G2401_SOP
- Sensor Box_SOP
- Temperature Controller_SOP
- TSI_FMPS_SOP
- TSI_OPS_SOP
- Monitoring_Van_Operation_SOP
- Meteorology_SOP

During field operations, two AQIS will operate the air monitoring van. One AQIS will drive (driver) and one AQIS will review instrument data in real-time (reviewer). The data will also be viewable remotely at the Special Projects' offices. If instrument issues arise, the mission may be paused depending on the issue. Should questions arise while operating or troubleshooting the air monitoring van, the reviewer can use Microsoft Teams chatting function or a mobile phone to call the Principal or Supervising AQIS for support.

Should laboratory analysis be needed, staff will follow existing guidance for sample transport and laboratory analysis. Sample analyses may be performed at the Air District Laboratory or other certified labs using applicable analytical techniques and methods. The Air District routinely transports and analyzes samples from a variety of existing monitoring systems and has SOPs in place for those purposes.

Please provide a timeline for air monitoring duration, frequency, and milestones.

Figure G2 provides a preliminary timeline for this air monitoring project. It is anticipated that monitoring will begin in Summer 2020, or roughly a month after ongoing shelter-in-place restrictions are rescinded.

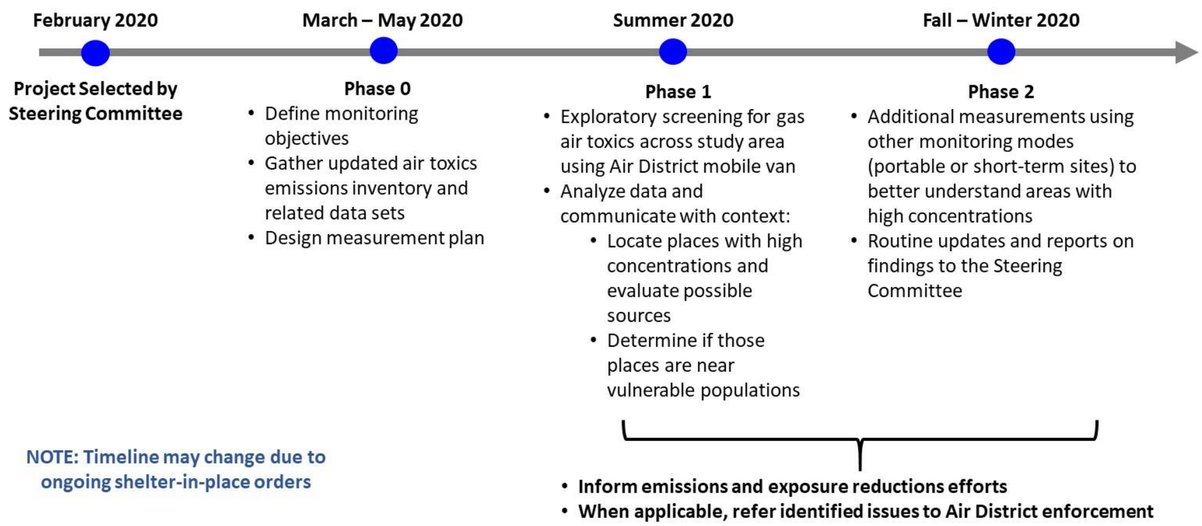

Figure G2. Estimated timeline for the air toxics monitoring project.

Given variable AQIS schedules, we expect to distribute start-up, driving, and shut-down tasks across AQIS to collect mobile monitoring data between the hours of 9 A.M. to 5 P.M., Monday – Friday. Based on our calculations, there are 138 miles of roadway in in our designated study region. We expect to drive a minimum of two days per week and an average of 6 hours per day – covering the entire study region every one to two weeks. As much of the literature on mobile monitoring has commonly reported, approximately 10 - 20 passes is optimal for providing a representative estimate of the spatial distribution of many pollutants over the term of the study; however, this depends on the spatial and temporal variability of the pollutant (Apte et al. 2017[3], Ranasinghe et al. 2016[4]). Areas with higher spatiotemporal pollutant variability will require more passes to achieve a representative concentration. Importantly, our objective is not necessarily to capture a representative pollutant concentration for an area, but rather to identify unknown hotspots and emitters in the study area. For that reason, we have decided to initially aim for 10-20 passes per road segment, evenly spread over different days of the week and times of day within our monitoring hours to ensure uniform and representative coverage over the study period. At one full pass of the study period per 1 –2 weeks, we anticipate reaching 10 – 20 passes per road segment in about 5 to 6 months. Note that prior to this Phase 1 monitoring period, we will need one month "start-up" time before collecting usable data upon returning to the lab after ongoing shelter-in-place restrictions due to COVID-19 are lifted. The duration and frequency of Phase 2 monitoring will depend in part on initial and ongoing results of Phase 1 monitoring, as well as which type

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[3] Apte, J. S.; Messier, K. P.; Gani, S.; Brauer, M.; Kirchstetter, T. W.; Lunden, M. M.; Marshall, J. D.; Portier, C. J.; Vermeulen, R. C. H.; Hamburg, S. P. High-Resolution Air Pollution Mapping with Google Street View Cars: Exploiting Big Data. Environ. Sci. Technol. 2017, 51 (12), 6999–7008. https://doi.org/10.1021/acs.est.7b00891

[4] Ranasinghe, D. R.; Choi, W.; Winer, A. M.; Paulson, S. E. Developing High Spatial Resolution Concentration Maps Using Mobile Air Quality Measurements. Aerosol Air Qual. Res. 2016, 16 (8), 1841–1853. https://doi.org/10.4209/aaqr.2015.07.0484

of instrumentation is deployed. As needed to inform specific objectives and as resources allow, Phase 2 monitoring will deploy portable monitors designed to provide temporal information at certain locations where Phase 1 monitoring has detected enhanced air toxics signals, but which temporally resolved emissions profiles are not achievable with the air monitoring van. Depending on the nature of the source and pollutant, the portable monitors may be deployed anywhere from one to three weeks.

Evaluating Effectiveness

What process is being used to ensure that air monitoring objectives are being met? How often are those evaluations conducted? How are effectiveness issues documented and addressed?

In keeping with the community-based approach to developing the monitoring plan, the Air District will partner with the community-led Monitoring Outreach Team to review and revise updates on the implementation of the monitoring project, data collected, and resulting analyses. These updates will be communicated regularly back to members of the Monitoring Plan Steering Committee, the Technical Advisory Group, the Community Emissions Reduction Plan Steering Committee, and the public. This process will help ensure that data are being used to meet community-prioritized monitoring objectives. These updates will also be posted on the Air District's Community Health Protection Program and Open Air Forum websites.

Data from the Air District's air toxics monitoring project will be quality controlled and analyzed on an ongoing basis to ensure that data are of sufficient quality to meet data quality objectives and sufficient robustness to meet air monitoring objectives. To that end, the Air District initially expects to conduct mobile monitoring with 10-20 passes per road segment across the study area, evenly spread over different days of the week and times of day within our monitoring hours to ensure uniform and representative coverage over the study period. Air District staff will meet regularly to discuss overall status of monitoring implementation, data collection, data quality control, and data analysis. Use of routine, established quality control and quality assurance measures and maintaining open, regular communication amongst project staff will help identify potential issues with monitoring instrumentation or other operational factors that may affect data quality. Corrective actions will be implemented and documented should such issues arise.

What is the end point for air monitoring with this project?

Data collected under this project are intended to, in part, help inform and support emissions and exposure reductions efforts in Richmond-San Pablo, particularly through the upcoming AB 617 Richmond-San Pablo Community Emissions Reduction Plan. It is anticipated that air monitoring will take place through the end of 2020 and into the first quarter of 2021 but may continue if needed and Air District resources are available. As noted above, monitoring will be considered complete once a minimum of 10-20 passes with the air monitoring van have been achieved throughout the study zone, along with any follow-up measurements using portable or short-term stationary monitoring. The timeline for data collection will also be subject to ongoing shelter-in-place and health conditions due to COVID-19.

Analyze and Interpret Data

What is the overall approach for preparing, analyzing and interpreting data to address project objectives?

Data that has been reviewed and finalized by AMSP will be output as CSV files and packaged in a directory containing a description of the project, along with data content and metadata to provide context for data use and analysis. The Air District's AAQA section and AIM Division will primarily conduct data analysis and interpretation on the collected data. Data analysis methods and selection of data analysis tools will be tailored to inform project monitoring objectives and specific data needs or questions identified by the Steering Committee. Geospatial data analysis tools, such as Geographic Information System (GIS) mapping, are expected to be utilized given that much of the air quality measurement data will be collected from a mobile platform. Viewing multiple data sets, such as air quality and meteorological measurements, emissions information, modeled concentrations, and locations with vulnerable populations, simultaneously will be advantageous for interpreting data. Additional techniques such as statistical analysis including box plots and scatter plots, timeseries analysis, wind and pollution roses, or source specific pollutant profile matching or source attribution or apportionment methods will also be used to help interpret data. Source attribution and apportionment analyses use emissions profiles from multiple sources and other information, such as meteorology data, to qualitatively or quantitatively assess individual contributions from those sources to ambient air pollution concentrations. These analyses can be performed using several methods, including positive matrix factorization or other cluster, factor, or multivariate statistical techniques. The Air District's Technical Assessment Team will consider the advantages and disadvantages of potential source attribution and apportionment methods and select the appropriate source attribution and apportionment method(s) for this project and include information about those approaches in the quarterly updates described below.

Communicate Results

How frequently and in what format (e.g., factsheets, reports, meetings) will information be shared with the community throughout the air monitoring process?

Project information will be communicated in a variety of ways and formats and the Air District will work directly with the Monitoring Outreach Team to ensure that project information is made accessible to the community and is delivered with community perspective and insight. The Monitoring Outreach Team will review public-facing updates and reports on monitoring projects and present those materials at public meetings as desired. Project progress updates and data and subsequent analyses, summaries, handouts, presentations, and or reports from Air District monitoring will be made available for download through the Air District's Community Health Protection Program and Open Air Forum websites. These updates will be made available on a quarterly basis while monitoring is ongoing, followed by a final report after the monitoring and subsequent data analysis are concluded. Final quality-controlled data may be provided in text files, spreadsheets, or potentially other formats. Data analyses, summaries, handouts, presentations, or reports will be provided in appropriate commonly used formats, such as Portable Document Format (PDF) files, Microsoft Word documents, and Power Point presentations. Any information and updates on monitoring projects will be made available to members of the Monitoring Plan Steering Committee, the Technical Advisory Group, the Community Emissions Reduction Plan Steering Committee, and the public.