BAY AREA AQMD

I. Basis and Rationale

This project is intended to address Section I.B.4: Analysis of Existing Data and Implementation/Development of Tools. The City of Richmond, California, in cooperation with the Bay Area Air Quality Management Agency (BAAQMD), has established a three-year community air monitoring program (http://www.fenceline.org/richmond/) intended to monitor emissions from the Chevron Richmond Refinery. This proposal is intended to use data analytics techniques to determine whether these techniques will allow us to see a signal corresponding to a level of emissions from the refinery once the impact of meteorological and other parameters are taken into account. These analytical techniques can be used to understand trends and anomalies in a large dataset that would almost certainly remain hidden if not discovered with these analytics. In addition, we would also analyze the existing data to determine whether there are covariates in the data set that would indicate that the sampling and monitoring can be streamlined to reduce costs and still maintain the integrity of the system. Finally, in conjunction with additional data being collected by the BAAQMD, this proposal is intended to determine whether source attribution for concentrations measured can be provided, potentially, on a real-time basis.

The original monitoring system was set up to provide the community with assurance that the refinery is not adversely impacting the nearby community with a secondary goal of ensuring that emissions from the refinery reflect those of a well-controlled source. However, the variation of other parameters that impact air quality, such as wind speed, wind direction, and other emissions sources such as the freeway and nearby rail yard serve to mask any variation in emissions that the monitoring program may otherwise detect. This program is designed to assist in fulfilling one of the original goals of the monitoring program: determine whether emissions from the refinery are changing concentrations of pollutants in the community. The secondary goals of this program are determining whether the monitoring program can be streamlined without loss of program integrity, and assessing the attribution of measured chemicals. While these were not goals of the original existing monitoring program, they can be accomplished within the framework of this proposed program and leverage the data collected as part of the original program.

The City of Richmond, California is a diverse, low income, community located at the center of numerous sources of Hazardous Air Pollutants (HAPs), including a large, complex refinery with an active marine terminal, two of the most trafficked freeways in Northern California (I-80 and I-580), a train yard, and other heavy industries, including a sulfuric acid plant. Although the results of the 2011 National Air Toxics Assessment (NATA) for the Richmond community are not exceedingly high, this is in part because the NATA is based on the National Emissions Inventory, which is in turn, based on reporting from stationary sources. The majority of air toxics emitted by refineries are released as fugitive emissions from tanks and process components. Recent studies using a variety of optical techniques indicate that the fugitive emissions from refineries are not well characterized using current emissions estimation tools. In addition, the refinery had a substantial fire in 2012 that resulted in a community emergency and lengthy shelter-in-place order. During and in the aftermath of the fire, over 15,000 local residents sought medical attention. After the fire, the City of Richmond and the refinery, with technical assistance from the BAAQMD, responded to community requests by installing and operating a complex fence-line and community air monitoring network.

The City of Richmond community air monitoring network is comprised of three open path fence-line air monitors located on the perimeter of the Chevron Richmond Refinery and three multipollutant air monitoring stations located in the residential communities of Atchison Village, North Richmond and Point Richmond. The fence-line systems are setup to analyze for benzene, hydrogen sulfide (H_2S), sulfur dioxide (SO_2), toluene, and xylene. The community air monitoring stations are setup to perform continuous monitoring of volatile organic compounds (VOCs), ammonia, black carbon, hydrogen sulfide, and particulate matter with an aerodynamic diameter of less than 2.5 microns ($PM_{2.5}$). A complete list of the monitoring technologies is presented in Table 1. In addition to the community monitoring program described above, the BAAQMD operates a continuous SO_2 and H_2S instruments and canister samples collected every 12 days and analyzed for a suite of hydrocarbons at one location in the city of Richmond and H_2S at an additional location. There is also a site approximately one mile downwind of the Chevron Refinery located in nearby San Pablo where SO_2, NO_2, CO, ozone, PM_{10}, $PM_{2.5}$, and ultrafine PM are continuously monitored with canister samples collected every 12 days and analyzed for a suite of hydrocarbons.

Table 1 – Equipment Summary

Equipment Type	Location	Sample Time	Detection Limit	Toxics
Open Path UV	Fence-Line	5 Minute	5 ppb	Benzene, Carbon Disulfide, Sulfur Dioxide, Toluene, Xylene
Open Path TDL	Fence-Line	5 Minutes	80 ppb	Hydrogen Sulfide
Gas Chromatography	Community	25 Minutes	0.5 ppb	Benzene, Toluene, o-Xylene, m,p-Xylene, Ethylbenzene, N-Hexane, N-Heptane, N-Octane, 3-Methylpentane, 1,2,3-Trimethylbenzene, 1,2,4-Trimethylbenzene, 1,3,5-Trimethylbenzene, 2,2,4-Trimethylpentane
UV Fluorescence	Community	5 Minutes	2 ppb	Hydrogen Sulfide
Chemiluminescence	Community	5 Minutes	2 ppb	Ammonia
Aethalometer	Community	5 Minutes	0.05 ug/m3	Black Carbon
Beta Attenuation	Community	1 Hour	6 ug/m3	Particulate Matter 2.5 micron

Data Reporting and Quality Assurance Plan

The community air monitoring equipment in Richmond has operated continuously since the commissioning of the systems in 2013-2014. The equipment is calibrated on a monthly basis and the validated data is stored electronically. Air monitoring locations operated by the BAAQMD have operated for significantly longer periods of time and meet all EPA siting and data reporting requirements and operated using Region 9 approved Quality Management Plan and Quality Assurance Project Plan requirements. The remainder of this document with concentrate on the community monitoring locations unless otherwise noted.

Data began being collected from a minimum of six air monitoring sample stations in 2014 at five minute intervals and include meteorological data (wind speed, wind direction, temperature, and relative humidity). The Richmond community monitoring stations are operated according to the EPA Quality Assurance Handbook for Air Pollution Measurement Systems Volume II Ambient Air Quality Monitoring Program. The meteorological systems are operated according to the EPA Quality Assurance Handbook for Air Pollution Measurement Systems Volume IV: Meteorological Measurements. This includes bi-month (every two weeks) zero and span checks for the analyzers as well as multipoint calibrations on a quarterly basis. The meteorological stations undergo annual multipoint calibrations.

Data from the air monitoring systems meet National Air Ambient Quality Standards for Data Management. Data from the field analyzers are logged at local workstations using a data logger. Raw data is archived locally but then sent to a central database where it is again stored. The data then undergoes Quality Assurance/ Quality Control checks where it is edited to remove calibration data, spikes associated with power issues, and other spurious data. Any data that is removed is flagged with the reason associated with the removal. Finally, corrected and adjusted data is stored in a database.

The system costs nearly $2 million to establish and nearly $375,000 annually to operate. However, due to the complexity of air monitoring interpretation, the program serves only to inform the community whether ambient air concentrations reach short-term exposure thresholds that may impact the health of the community. The program does not provide information on the source of ambient air concentrations or information on whether refinery emissions are increasing or decreasing over time. This proposed program is intended to maximize returns on the investment for the community and perform more detailed analysis on the wealth of data collected. In addition, the BAAQMD recently implemented a requirement for similar mentoring programs near the other four refineries in the BAAQMD. If successful, the results of this proposed program can be used to substantially enhance the value and potentially reduce the cost of the other refinery monitoring programs to be established by BAAQMD.

II. Technical Approach

There are three project objectives for this project:

1) Use data analytics techniques on the existing large ambient air monitoring data set to determine if a Hazardous Air Pollutant (HAP) emissions signal from a refinery that is adjacent to an EJ community can be determined;
2) Evaluate whether there is covariation within the nearly 20 concentrations measured to allow a reduction in the parameters measured and a concomitant reduction in costs without compromising the integrity of the program; and
3) Combine data analytics and dispersion modelling with the USEPA's Positive Matrix Factorization (PMF) model to evaluate whether the distinct sources of ambient air concentrations can be determined, potentially, on a real-time basis.

Project objective number one and number three are the key objectives that will allow far better use of the data than is currently experienced. Ideally, the data analytics techniques, once established and tuned through the use of machine learning, will be installed within the web-based community access page and will allow the community and the refinery to, on a real-time basis, understand the sources of air concentrations measured at the fence-line and within the community.

The proposed project plan is as follows:

1. Obtain time resolved QA/QC'd data from the three fence-line and community monitoring systems, plus nearby BAAQMD monitoring locations, as well as a suite of meteorological data including wind speed, wind direction, stability, temperature and precipitation.
2. Obtain time-resolved emissions data from Continuous Emissions Monitors (CEMs) systems within the refinery required by BAAQMD.
3. Perform deterministic dispersion modelling with the robust meteorological dataset to understand pollutant dispersion and use estimated dispersion factors as a covariate in subsequent regression and PMF analyses.
4. Put aside a set of training data to establish a multivariable statistical analytical system to test for highly predictive covariates and establish when the data follows emissions trends with an emphasis on measured SO_2 and H_2S emissions. This technique will enable the achievement of objective number one.
5. Evaluate whether a similar trend is seen with hydrocarbon data in accordance with objective number one (Use data analytics techniques on the existing large ambient air monitoring data set to determine if a Hazardous Air Pollutant (HAP) emissions signal from a refinery that is adjacent to an EJ community can be determined).
6. Use receptor-based source apportionment, also known as receptor modelling or PMF, to isolate the fraction of observed monitor concentrations that are caused by distinct emission sources.
7. Combine receptor modelling with deterministic dispersion modelling to evaluate whether the sources of ambient air concentration can be determined in real-time to achieve objective number three.
8. Establish proof of concept and highlight sampling parameters that were found to have covariation.

I. Data Analysis

Four main analytical techniques will be applied to support the project objectives: 1) Deterministic dispersion modelling (to be used in conjunction with techniques number 3 & 4), 2) Classical statistical and correlation assessments, 3) Multivariate regression using genetic algorithms, and 4) Receptor modelling (or PMF) combined with dispersion modelling. Each analytical technique is described below with information describing how they support the project objectives and how the techniques will be used and combined.

A. Deterministic Dispersion Modelling

Most dispersion models, given a single emissions scenario and a meteorological dataset, produce a single prediction, e.g. a time series of concentrations at each receptor location. They are deterministic, rather than stochastic. Meteorologists typically resort to ensemble methods to introduce variability and probability (confidence intervals), by varying the input datasets or which model is being used for each ensemble member's prediction. But deterministic models can also be used as a component of other probability methods, such as the multivariate regression and PMF approaches discussed in subsequent sections of this proposal. The deterministic dispersion model output could also be displayed in real-time on the Internet, to aid the public in interpreting the real-time display of concentrations. This portion could be thought of as a real-time plume visualization method.

We propose to implement the most recent version of the CALPUFF dispersion model, running on a dedicated server in the Cloud (Google Cloud Platform, Amazon Web Services, Microsoft Azure, etc.) with an HTTP interface. The system would use all the available meteorology measured in the area, both by the Community Air Monitoring Program, the BAAQMD and by local participants of the Citizen Weather Observer Program (CWOP, available in a real-time from www.weatherunderground.com and weather.gladstonefamily.net). Compound concentrations and/or emission rates for many pollutants emitted from the refinery are continuously monitored and collected by the BAAQMD. We also suggest including the railyards and local freeways, using emission estimates temporally allocated by e.g. SMOKE (a method typically used to prepare emissions for photochemical grid modeling).

The system would produce a plot showing contours of predicted concentration, every hour. If so desired, it could produce multiple plots per hour (e.g. every 15 minutes, or every 10 minutes) because CALPUFF, unlike most other dispersion models, is designed to handle sub-hourly time-steps. The time-step would need to be greater than or equal to the update interval of the meteorology (5 minutes). Unlike Gaussian dispersion models such as AERMOD, CALPUFF can utilize multiple meteorological stations to create a 3-dimensional wind field. The plumes, represented by a series of discrete puffs, can bend and follow the complex airflows affected by terrain.

Members of the BAAQMD team have implemented the CALPUFF model in a similar fashion for Great Basin Unified Air Pollution Control District, see http://www.gbuapcd.org/owenslake/yesterday/animations.php. GBUAPCD collects meteorology and sand flux measurements on a daily basis, and posts the data each morning on their FTP site. The project servers download that data and other public data, run the CALPUFF system, produce plots, and upload them back to their servers each morning.

B. Classical statistical and correlation assessments

The first step in any data analytics project is to explore and understand the data prior to engaging in any regression or more rigorous modelling approaches. We propose to first explore the dataset to understand data range and distribution, trends, or outliers. Classical statistical techniques will be employed to understand any correlation and covariation in the data. This analysis will explore objective number two to evaluate whether any covariation trends and opportunities for system refinements. We will evaluate if there are any highly correlated pollutants that can be predicted with high accuracy (taking into account detection limits and data resolution) and that no outliers exist within the pollutant relationship for the entirety of the 3-year sampling history under consideration (2014 – 2016).

C. Multivariate Regression using genetic algorithms

Through the use of multivariate regression analysis, it may be possible to identify patterns and anomalies in the monitor dataset to develop predictive insights and warnings of unusual events. This analytic approach will enable the achievement of objective number one (Use data analytics techniques on the existing large ambient air monitoring data set to determine if a Hazardous Air Pollutant (HAP) emissions signal from a refinery that is adjacent to an EJ community can be determined), to find HAPs emissions signal from the refinery adjacent to the monitored EJ community. This regression analysis would need to account for meteorological variations such as atmospheric pressure, humidity, wind speed and direction, which can be accounted for using the results obtained from deterministic dispersion modelling (described above). Cultural aspects such as the working week, time of day, and local events, and notable changes industry and transport may also need to be considered and may be included if funding is available.

Because of the size and complexity of the dataset, we propose using genetic algorithms. These would automatically generate very large numbers of candidate relationships across a wide array of dimensions (these dimensions consisting of the many variables used to explain changes in pollutant concentrations), evaluate the usefulness of these relationships, and continually mix and tweak them over a long series of "generations". In this way, promising relationships in the data can be discovered automatically. These can then be used to help understand trends and anomalies in a large dataset, which would almost certainly remain hidden if not discovered by the genetic algorithm. Members of the BAAQMD Team have successfully applied genetic algorithms in developing a computer-based "expert system" for Network Rail, the UK's national railway owner, to distribute to contractors, so they can easily identify under-strength bridges in the national rail network. Developing the tool involved embedding a commercial bridge assessment program within specially written software. Once a model has been developed to predict the population baseline behavior (meaning "normal daily operations"), sample deviations (abnormal behavior, i.e. events) could be assessed for statistical relevance using hypothesis testing.

D. Receptor Modelling

Receptor-based source apportionment, also known as receptor modeling, will be used to isolate the fraction of observed monitor concentrations that are caused by distinct emission sources. Knowing which sources have the largest impacts, or contribute to significant peak events, can be critical for the development of efficient mitigation strategies, can more clearly inform the public about air quality issues, and can serve as a way of tracking contributions by certain source-types (e.g., vehicles, wind-blown dust, refineries). This type of analysis is commonly conducted using the USEPA's Chemical Mass Balance (CMB) model,[1] the USEPA's Positive Matrix Factorization (PMF) model,[2] or using advanced techniques with the Multilinear Engine 2 (ME-2).[3]

A review of the data will consider the number of records available, the uncertainty associated with the measurements, signal-to-noise ratios of the individual species, and whether the monitored species are useful for discerning chemical fingerprints of significant sources expected to impact the monitoring network. If the data are suitable for receptor modeling, then CMB and/or PMF will be applied to quantify the source-types that are significant contributors at each site. These results will highlight the source-specific contributions to air measurements over time and, in the case of PMF or ME-2, will also approximate the chemical fingerprint of the sources identified by the model.

Advanced methods of receptor modeling will be carried out with ME-2. The data from each Richmond monitoring site will be aggregated into a single model and assessed using a multi-site approach. Several previous studies have assessed spatially and temporally varying source contributions using PMF and ME-2 with data from multiple sites.[4–18] Results from multi-site analyses can provide an improved depiction of community-scale influence of different emission sources, enabling the achievement of objective number three (Combine data analytics and dispersion modelling with the USEPA's Positive Matrix Factorization (PMF) model to evaluate whether the distinct sources of ambient air concentrations can be determined, potentially, on a real-time basis).

Additional ME-2 modeling methods that allow for the incorporation of additional data may be explored. These advanced modeling methods attempt to inform the receptor model by imposing constraints using temporal, spatial, physical, or chemical data. For example, these additional data could include meteorological back trajectories, chemical transport model output, or source-specific tracer species constraints. Partially constraining the model has proven to be useful for separating ubiquitous sources from those only identified at a subset of the sites.[19–22] In the case of back trajectories, the spatially-informed model could produce source location maps of each of the model-resolved source-types.

II. Environmental Justice Impacts

Richmond, CA is situated in the East Bay region of the San Francisco Bay Area metropolitan area. Richmond is home to approximately 106,000 residents that reflect a blend of cultures and ethnicities of many cities in the United States. Richmond is a majority community of color, and among the most diverse places in California. Thirty-three percent of Richmond's population is foreign-born residents, and 49.9% speak a language other than English at home. BAAQMD's and Richmond's policy goals aim to tackle the environmental, social, and health disparities that too often afflict communities of color in the United States. Today, over 17% of Richmond residents live below the poverty line – including more than 25% of all children. Richmond's median income of $54,857 is the second lowest in the entire nine county Bay Area.

Richmond hosts one of the largest oil refineries in California, numerous chemical and industrial manufacturers, a regional solid waste facility, industrial recycling facilities, a major port, major railways, Interstate 580, Interstate 80, and the Richmond-San Rafael Bridge toll plaza. Richmond also faces the negative ancillary effects of hosting these facilities, including disincentivized private investment. Richmond is listed as among one of most impacted "Disadvantaged Community" by CalEnviroScreen 3.0 (https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-30) with significant public health and environmental effects from all sources of pollution. CalEnviroScreen 3.0, a screening tool that uses a set over 20 indicators to identify communities most burdened by pollution from multiple sources and most vulnerable to its effects, considering their socioeconomic characteristics and underlying health status. BAAQMD has identified Richmond as a "CARE community" under the Community Air Risk Evaluation Program that unites government, communities, and businesses to address areas of concentrated air pollution and related public health effects in the Bay Area. The CARE Program aims to reduce these health impacts linked to local air quality, and creates a partnership with impacted communities.

To this end, BAAQMD recently partnered with Richmond to continue to take a proactive approach in planning initiatives to address these inequities with the development of the Richmond Climate Action Plan that integrates a health and social equity focus, and climate action goals that consistent with BAAQMD's Clean Air Plan. Both BAAQMD and the City of Richmond developed robust community working groups that engaged local stakeholders and community based organizations throughout the development of the Climate Action and Clean Air plans. Actions within this grant proposal will reengage the community members with a renewed focus on detailed data analysis from the Richmond Community Air Monitoring program within the most burdened and vulnerable communities. The findings from the air quality analysis may help alleviate existing health and social inequities by addressing some of the upstream root causes, sources, and trends of toxic air pollutants.

III. Community Collaboration / Outreach

The City of Richmond and BAAQMD will organize four community meetings with residents, and environmental justice community organizations. The meetings will serve as a forum to create a Clean Air Working Group comprised of air quality technical experts from the BAAQMD Team, and local community experts that are familiar with the nuanced local environmental considerations and neighborhood-level synergies and impacts. The four meetings will include the following themes and goals:

Meeting #1 - Form a community working group, introduce and refine project scope, and seek input on how to maximize user experience design with the data and community air monitoring website;
Meeting #2 - Review work plan scope, and identify additional areas of data analysis sourced from community-member and local stakeholder expertise;
Meeting #3 - Review draft results, identified trends and findings, and seek input from working group on draft mitigations; and
Meeting #4 - Present the final report and determinations, and a video summary for social media and the air quality monitoring website.

Community engagement strategies include noticing community meetings and opportunities to participate in the working group over the following media:

- Release of a formal press release in partnership with BAAQMD and the Richmond Mayor's Office
- Develop bilingual flyers to notice formation of community working group
- Richmond City Manager's Listserv (Over 1,000 subscribers)
- Richmond Health and Environmental Initiatives Listserv (Over 2,000 subscribers)
- Richmond Facebook and Twitter accounts (Over 1,500 followers)
- Richmond Mayor E-forum listserv (Over 3,000 subscribers)
- Invitations disseminated and shared with Richmond's robust Neighborhood Coordinating Councils, community-based organizations, local newspapers, places of worship, chamber of commerce and local business forums
- Renewed outreach and engagement of community based organizations participating in the Richmond Climate Action Plan and BAAQMD Clean Air Plan

IV. Environmental Results: Outcomes, Outputs, Performance Measures

The results of this project's modelling outputs are designed to inform the affected community to take actions to reduce exposures to HAPs, allow the BAAQMD to evaluate and enact control measures to decrease emissions, enable the City of Richmond to make appropriate land-use decisions to reduce exposures and potentially enable similar uses at other large facilities in keeping with EPA's strategic plan.

Short- and Mid-Term Products

- Validation of monitoring data set
- Modelling results and evaluation of model performance
- Increased community awareness of monitoring data and its uses
- Potential identification of emissions impacts
- Additional exposure information of residents
- Potential focusing of existing and future monitoring resources

Mid- and Long-Term Products

- Informed and targeted local regulation to reduce TAC exposure
- Potential forecasting of emissions impacts

- Informed and target land-use decisions

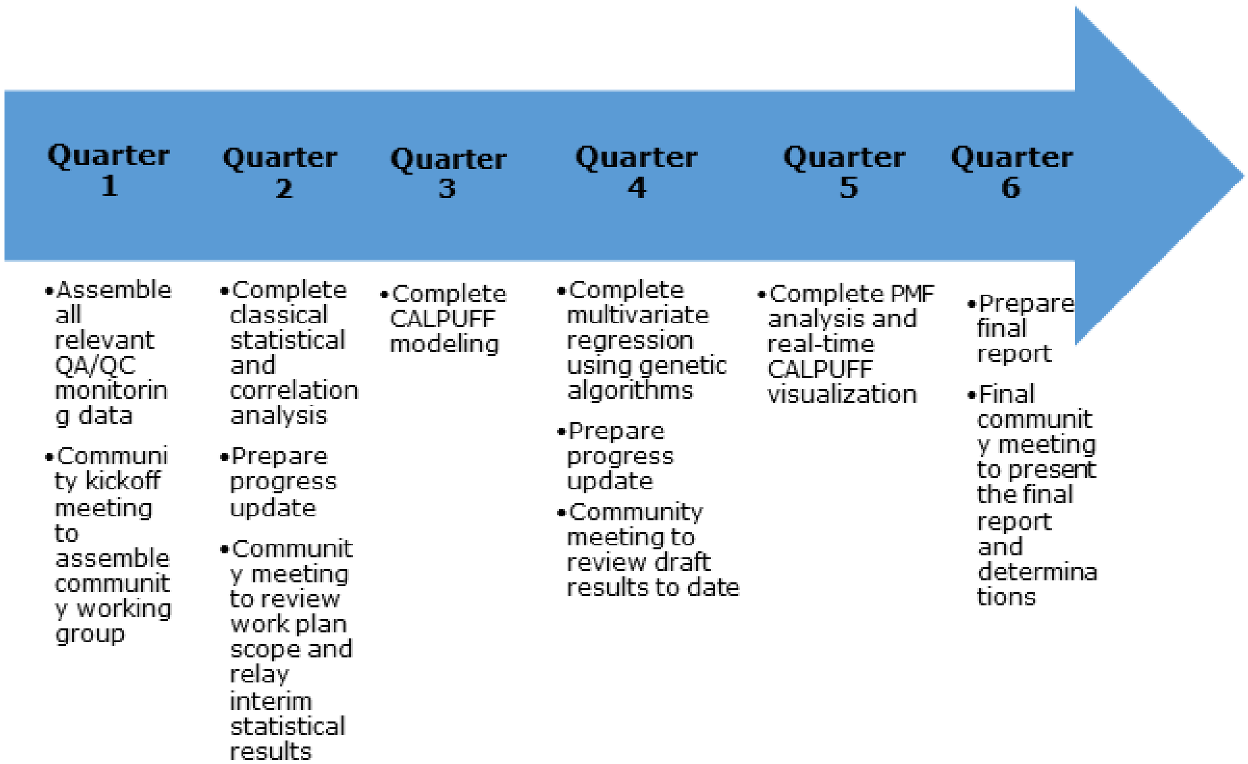
Link Between Short-, Mid-, and Long-Term Products

The planned long-term outcomes of this project are reduced TAC emissions, concentrations and exposures in the Richmond area that may be applied to other locations. The short- and mid-term products may result in better modelling outcomes by utilizing additional data analysis tools to produce more actionable and reliable outcomes.

Progress Tracking

Project planning, data and team coordination will begin within one month after the grant is awarded and will include weekly meetings of the project team. Figure 1 below outlines the timeline for completing project objectives.

Figure 1 - Project Timeline



V. Programmatic Capability and Past Performance

The BAAQMD receives, successfully completes and administers the following EPA grants on an ongoing basis –

- 105 Air Pollution Control Program Grant that includes pass-through funds for the California Air Pollution Control Officers Association (CAPCOA) for smaller California Air Districts
- 103 Air Pollution Control Program Grant for $PM_{2.5}$
- 103 National Ambient Air Toxics Trends Station (NATTS) Grant
- The BAAQMD has received and successfully completed the following non-recurring EPA grants –
- NO_2 Near Roadway Monitoring Grant
- Piston/Regional Airport Lead Monitoring Grant

- CAPCOA Training Grant
- California Air Monitoring Network Assessment Grant
- The BAAQMD receives, successfully completes and administers and on-going grant from the Department of Homeland Security for monitoring

VI. Detailed Budget Narrative

Table 2 below provides a detailed breakout of the approximate funding used for each major activity outlined in this proposal. The proposed budget only includes federal funding to complete the project objectives, as a significant cost is being leveraged from the capital and operational costs of the Richmond Community Monitoring program already in place. Further detail on leveraged funds and resources can be found in the following section of this proposal. The BAAQMD expects that costs associated with managing the process, attending meetings and participating in data analysis will result in significantly more costs than the estimated $50,000 plus fringe benefits provided below. Any additional costs will be considered "in-kind" payments and the BAAQMD will not request additional reimbursement beyond that presented below.

Table 2 - Proposed Budget

	EPA Funding
Personnel	
TOTAL PERSONNEL	$50,000
Fringe Benefits	42%
TOTAL FRINGE BENEFITS	21,000
Travel/Equipment/Supplies	$0
TOTAL TRAVEL/EQUIPMENT/SUPPLIES	$0
Contractual	
Ramboll Environ Contract (Data Analysis)	$150,000
City of Richmond Contract (Community Outreach)	$50,000
Argos Scientific, Inc. Contract (Monitoring Network, QA/QC Data)	$50,000
TOTAL CONTRACTUAL	$250,000
Other	
TOTAL OTHER	$0
TOTAL FUNDING	(fed) $321,000

TOTAL PROJECT COST (federal)	$321,000

VII. Leveraging

This proposed program leverages the funds that have been invested by Chevron in the Richmond community monitoring program. As noted earlier, this program costs $2MM for capital costs, and costs approximately $375,000 to operate annually. This program, if successful, will allow for far greater use of the data and for far greater community understanding of the air quality in their neighborhood. If the program determining covariates is successful, the same quality of data may be obtained for a lower cost and allow for investments in additional air monitoring or mitigations. This has the potential to similarly impact the monitoring conducted under the BAAQMD Regulation 12, Rule 15, requiring fence-line and community monitoring at all 5 refinery locations in the Bay Area and may also be applied to other large facilities. If savings can be established due to the determination of covariates, annual operating savings will help achieve investment in community health and environmental programs. Findings of this study may be replicable in other monitoring programs.

VIII. Expenditure of Awarded Grant Funds

The BAAQMD has appropriate mechanisms in place to ensure that every expenditure associated with awarded grant funds are tracked and documented, including personnel costs. The BAAQMD has been audited by both the EPA and the Department of Homeland Security within the last 5 years and there were no major findings associated with financial practices and procedures.

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