DRAFT Rule 1180 Community Air Monitoring Plan

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
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NOTE: This Community Air Monitoring Plan (CAMP) will be released for public comments prior to its adoption to provide an opportunity for input from community members, industry stakeholders and other interested parties. This plan is envisioned as a living document, thus portions of the community air monitoring network or monitoring approaches may be modified based on community feedback and analysis of air monitoring data once air monitoring commences.

1 Background

Petroleum refineries are among the largest stationary sources of air pollution in the South Coast Air Basin (Basin). These facilities process crude oil into various products, such as gasoline, diesel, and aviation fuels, other fuel oils, liquefied petroleum gas, kerosene, lubricating oils, and feedstock for the petrochemical industry. The processing of crude oil at petroleum refineries can result in emissions of particle and gaseous pollutants including toxic air contaminants. For example, Volatile Organic Compounds (VOCs) are gaseous pollutants that are emitted from the petroleum refining process (e.g., leakage, venting, and evaporation of the raw materials and finished products) (*Nelson*, 2012; *South Coast AQMD*, 2016; *Ragothaman and Anderson*, 2017). Significant amounts of sulfur oxides, nitrogen oxides, hydrogen sulfide, particulate matter, and several toxic species can also be generated from operations specific to this industry. Air pollutant emissions can be associated with a variety of refinery related activities, such as catalytic or thermal cracking, catalytic reforming, sulfur recovery, fluid coking, vacuum distillation, and wastewater. Fugitive emissions can also originate from storage tanks and other equipment leaks, cooling towers, blow-down systems, steam boilers, process furnaces, process heaters, compressor engines, and product loading/unloading operations.

In recent years, community concerns over emissions from refineries (e.g., routine facility operations, fugitive leaks, and potential releases due to upset conditions or emergency situations) and the potential for community exposure to harmful air toxic pollutants has increased. For example, the explosion at the former Exxon-Mobil Refinery in Torrance in 2015 (*South Coast AQMD*, 2018a), as well as other refinery incidents in the Bay Area (e.g. *BAAQMD*, 2012) and elsewhere in the United States, have added to a heightened level of community concern.

The development and implementation of refinery-related air monitoring, including fenceline air monitoring systems and a neighborhood scale air monitoring network will, result in valuable air quality data to assess the potential impact of refinery emissions in nearby communities. Such measurements can also be used to alert the public in case the concentration of the monitored air pollutants may cause health related concerns. It should be noted that fenceline monitoring focuses on characterizing local air toxic impacts, and there may be additional contributions of air toxics to the total air pollution burden in the communities from the region. Also a fenceline

monitoring network could be able to differentiate between emissions from the refineries and those from other contributing sources such as motor-vehicles.

The South Coast Air Quality Management District (South Coast AQMD) has undertaken in the past, and is currently conducting studies to assess the level of air toxics and other air contaminants around and near refineries. These studies include projects focused on refinery monitoring, technology demonstration, an extensive Optical Remote Sensing (ORS) field measurement campaign in Fall 2015 (*South Coast AQMD*, 2017a), and ongoing work involving periodic ORS mobile surveys of all major refineries and neighboring communities in the Basin. These efforts have resulted in increased confidence that ORS as well as other optically-based measurement techniques and instrumentation can be successfully used to augment refinery fenceline and community air quality measurements.

Refinery related monitoring is also a component of the advanced monitoring portion of the fifth South Coast AQMD Multiple Air Toxic Exposure Study (MATES V), which is currently ongoing (*South Coast AQMD*, 2018). Within MATES V, an optical tent is being developed and implemented at one of the refineries in the Basin for near-real-time monitoring of benzene, toluene, and xylene emissions. The optical tent (which uses ORS technology) will operate 24 hours a day, seven days a week, and will allow for the characterization of long-term refinery emissions. It also will provide near real-time data to evaluate emissions at different times of the day, and will help identify leaks.

1.1 Overview of Rule 1180 – Refinery Fenceline and Community Air Monitoring

Rule 1180 was adopted by the South Coast AQMD Governing Board on December 1, 2017. It applies to all large petroleum refineries that are permitted and regulated by the South Coast AQMD, and requires these facilities to collect real-time data of refinery air pollution emissions at or near their property boundaries, and to provide data quickly to the public. Petroleum refineries that have a maximum capacity to process less than 40,000 barrels of crude oil per day are exempt from the requirements of Rule 1180. The rule requires petroleum refineries to install and operate continuous, fenceline air monitoring systems to monitor a comprehensive list of criteria pollutants and toxic air contaminants in real-time. Rule 1180 also establishes a fee schedule, to be paid by the petroleum refineries, for the cost of designing, developing, installing, operating and maintaining refinery-related community air monitoring systems. Rule 1180 implements and satisfies the air monitoring requirements for petroleum refineries mandated by Health and Safety Code §42705.6 (*Assembly Bill 1647*, 2017). This law requires a refinery-related fenceline and community air monitoring systems to be installed for each major petroleum refinery in the Basin, to collect real-time data from these monitoring systems, to provide the monitoring results as quickly as possible in a publicly accessible format, and to maintain records of that data.

In the Basin, there are seven facilities that have to satisfy the requirements of Rule 1180:

- Marathon Petroleum Corporation (formerly Andeavor Corporation), Carson Refinery; Carson, CA
- Marathon Petroleum Corporation (formerly Andeavor Corporation), Wilmington Refinery; Wilmington, CA
- PBF Energy, Torrance Refining Company (formerly Exxon-Mobil); Torrance, CA
- Chevron U.S.A. Inc., Chevron El Segundo Refinery; El Segundo, CA
- Phillips 66 Company; Carson, CA
- Phillips 66 Company; Wilmington, CA
- Valero Wilmington Refinery; Wilmington, CA

This Rule 1180 Community Air Monitoring Plan (CAMP) outlines the South Coast AQMD's strategy and approach for conducting air monitoring in communities adjacent to the above-mentioned refineries, as part of Rule 1180 implementation. A Community Air Monitoring network will be developed and operated by the South Coast AQMD based on the information provided in this CAMP. A related Quality Assurance Project Plan (QAPP) and all relevant Standard Operating Procedures (SOPs) for the air monitoring equipment described in this CAMP will be released as separate documents. Refinery fenceline monitoring, which is also required under Rule 1180, will be conducted by the refineries and draft fenceline air monitoring plans are publically available on the South Coast AQMD website (*South Coast AQMD*, 2019).

1.2 Rule 1180 Community Air Monitoring Objectives and Timeline

The specific objectives of Rule 1180 refinery-related community air monitoring include the following:

- Implement a robust and near real-time (whenever possible) community air monitoring network near refineries;
- Provide near real-time air quality information through a dedicated data portal and website to inform the public of current air quality conditions in their community;
- Collect air pollution data suitable for short- and long-term air quality assessments;
- Provide up-to-date community air quality data;
- Identify non-refinery emissions sources affecting air quality in a given community;
- Improve the public's understanding of air pollution and promote awareness of the potential impact of refinery emissions on air quality through public education; and
- Track progress in improving community air quality.

During the rulemaking process, it was established that a total of ten community air monitoring stations shall be developed in communities adjacent to the seven major refineries subject to Rule 1180. The estimated number of community air monitoring stations and their distribution and attribution among the refineries are presented in Table 1. The number of community stations near each refinery is based on the size of the refinery and paid for by the established Rule 1180 requirements.

Table 1: Number of Community Air Monitoring Stations Planned Near Each Refinery

Refinery	# of Stations	Potential Communities
Marathon, Carson (formerly Tesoro Carson)	3	Carson / West Long Beach
Marathon Wilmington (formerly Tesoro Wilmington)		Wilmington / West Long Beach
Torrance Refining Company (former ExxonMobil)	2	Torrance
Chevron El Segundo	2	El Segundo / Manhattan Beach / Hawthorne / Del Aire
Phillips 66 Carson	2	Carson / Wilmington
Phillips 66 Wilmington		Wilmington
Valero Wilmington	1	Wilmington

The estimated timeline for the design, development, and implementation of this CAMP is based on the requirements of Rule 1180 and is provided in Table 2.

Table 2: Implementation Timeline for this CAMP

Action	Estimated Schedule
Public meetings to introduce community air monitoring concepts to communities	June 2019 (completed)
Release of Draft CAMP for 21-day public comment period	November 11, 2019
Public meeting to solicit feedback on Draft CAMP	Early December 2019
Finalize CAMP based on public input	December 2019
Purchase specialized equipment and instruments	August - November 2019
Secure Community Air Monitoring Sites	Before December 2019

Installation of stations and instruments, calibration and testing of equipment	October – December 2019
Implementation of data display platform	Before December 2019
Start operating community air monitoring network and displaying monitoring data to the public	January 2020

2 Community Air Monitoring Implementation

The design and implementation of this CAMP consists of the three main components listed below and described in detail in subsequent sections of this document:

2.1 Development and implementation of a community air quality monitoring network
2.2 Public data display and notification
2.3 Community and stakeholders outreach, education, and engagement

2.1 Development and Implementation of a Community Air Quality Network

The proposed refinery-related community air monitoring network will include up to ten fully equipped fixed-site air monitoring stations (Figure 1 presents examples of such stations) in communities near the refineries that are subject to Rule 1180. Air monitoring equipment will be placed in climate-controlled enclosures (e.g. 20-ft shipping containers, or trailers) or in existing structures (if available). The selection of air monitoring equipment will have to satisfy both the short- and long-term objectives of refinery-related community air monitoring. Long-term monitoring is essential to assess trends and potential air quality impacts from refinery emissions, and the equipment selected for this purpose should be able to detect typical urban variations of the target pollutants. Short-term monitoring is necessary to evaluate the immediate impact of fugitive emissions (e.g. leaks) and other releases in the surrounding communities, and will require monitoring equipment with high time-resolution and reporting data in real-time or near real-time. This section discusses the approach taken by South Coast AQMD staff to identify communities near refineries, locations within these communities appropriate for a community monitoring station and the selection of air monitoring instrumentation.

Figure 1: Examples of typical fixed-site air monitoring stations.

2.1.1 Community Air Monitoring Site Selection

Up to ten fixed, long-term community air monitoring stations will be established as part of Rule 1180 community air monitoring implementation. These stations will be selected to be representative of typical air quality conditions in communities around the refineries, and to characterize air quality and potential impacts that may result from refinery-related operations. Therefore, the following site selection criteria were considered:

- Proximity to the refinery and other potential sources;
- Proximity to the community and other sensitive receptors;
- Local meteorology (at least one community station will be placed downwind of each refinery);
- Available infrastructure (e.g. space, power, etc.);
- Long term availability of the site;
- Appropriate siting for ambient air monitoring station (e.g. comply with applicable U.S. EPA siting requirements (*U.S. EPA*, 2007));
- Ease of access to the site (e.g. around the clock and weekend access is desired);
- Safety;
- Environmental justice considerations; and
- Input from community members, city officials, industry, first response agencies, and other stakeholders

Figure 2 summarizes the main elements that will be evaluated in the site selection process. Individual criteria considered in the site selection process are described in the sections below. During site selection process, South Coast AQMD staff identified fifty one (51) potentially suitable community air monitoring sites. Potential sites were ranked based on the criteria presented in Figure 2, and the final selection will be based on ability to obtain site access permissions.

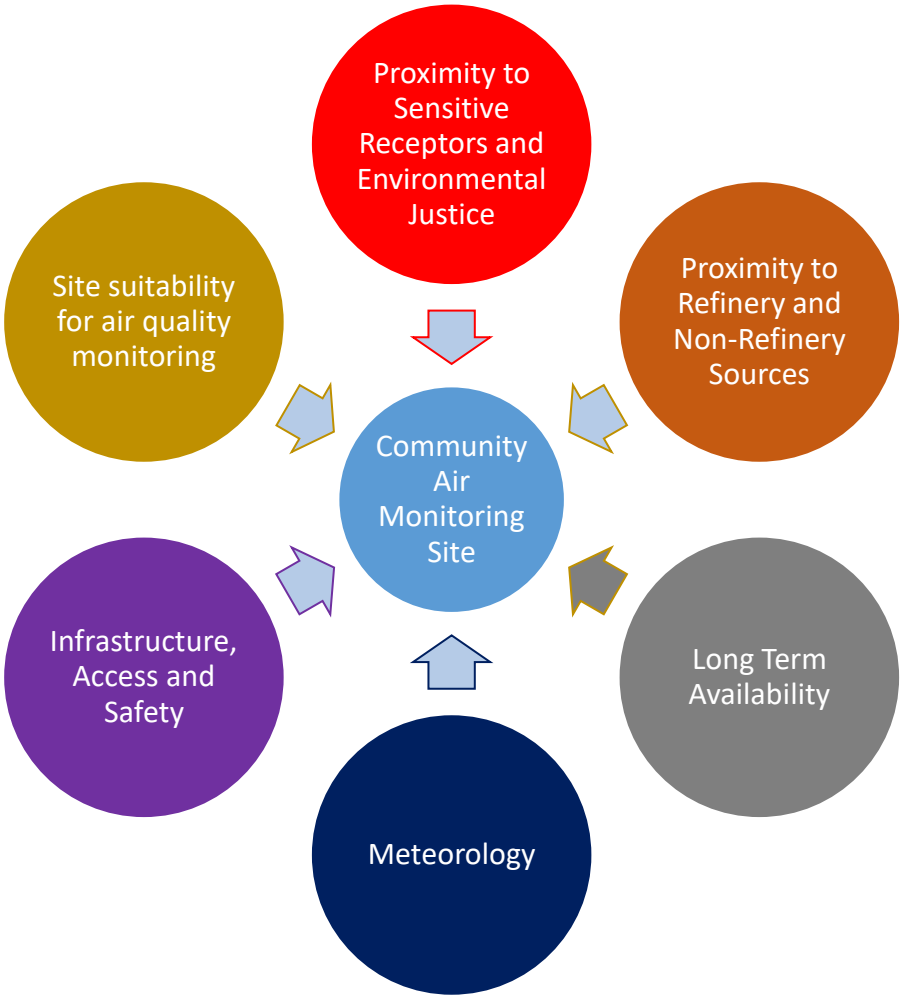

Figure 2: Main elements that are being evaluated as part of the site selection process for Rule 1180 Community Air Monitoring.

Figure 3 identifies a map of all petroleum refineries subject to Rule 1180 and outlines geographical areas surveyed by South Coast AQMD staff to find potential locations for community air monitoring sites. The seven refineries subject to Rule 1180 and surrounding regions were grouped into three areas based on their geographical location within the Basin (Figure 3). This subdivision was done because the local meteorological conditions and geographic layout vary widely between the regions considered. For this reason, each community air monitoring station will be equipped with a meteorological station. It is also important to note that the boundaries of the three regions outlined in Figure 3 are not formally defined, and are only for the purpose of this discussion and for selecting community air monitoring sites.

Figure 3: Satellite image showing the refineries subject to South Coast AQMD Rule 1180. The red boundaries delineate the regions considered in the selection of community air monitoring sites.

2.1.1.1 Carson, Wilmington and Long Beach Communities (Region 1)

Carson, Wilmington and Long Beach include five major refineries, a number of other pollution sources (e.g. tank farms, oil wells, ports, and railroads) and multiple communities. The Marathon and Phillips 66 Carson refineries are adjacent to each other and the Marathon Wilmington refinery is also in close proximity. The Phillips 66 Wilmington refinery is located in the southwest

portion of this region and the Valero Wilmington refinery is on the southern end of this geographical area. Valero Wilmington is one of the two refineries in the Basin that uses modified hydrogen fluoride (HF) in its operations (*South Coast AQMD*, 2019b). This pollutant will be continuously monitored at the community air monitoring station nearest to the Valero Wilmington refinery using real-time instrumentation capable of detecting very low HF concentrations (see Table 4 for instrument specifications).

The Region 1 area includes the cities of Carson, Wilmington and Long Beach. The residential areas surrounding these refineries are home to numerous schools, parks and businesses. The West Long Beach community lies approximately 1,000 meters (~3,000 ft) east of the Marathon-Wilmington refinery. Residential areas in the City of Carson located to the north of the Marathon Carson refinery and to the east of the Phillips-66-Carson refinery are within approximately 300 meters (~900 ft) of the refinery fencelines. The Wilmington residential community is located directly to the south of the Phillips-66-Carson refinery with residences approximately 700 meters (~2,200 ft) from the refinery fenceline. The Wilmington residential community also shares a border with the Phillips-66-Wilmington refinery, with residences within approximately 30 meters (less than 100 ft) from the refinery fenceline.

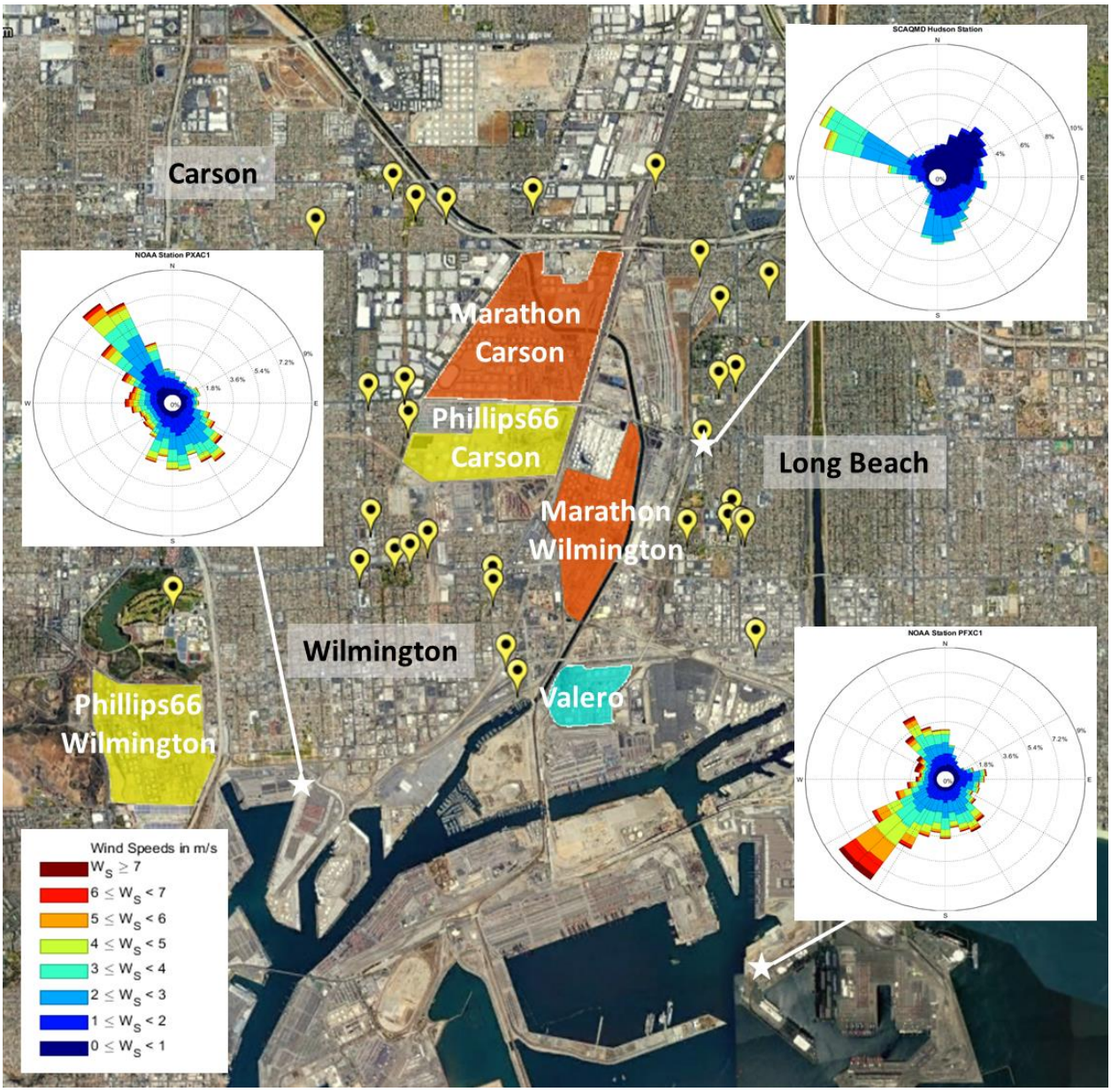

Figure 4: Satellite image of the Carson, Wilmington, and Long Beach region (Region 1) which includes five major refineries. The yellow markers indicate the locations of potential sites for community monitoring evaluated by the South Coast AQMD staff. The wind roses were obtained using data from National Oceanic and Atmospheric Administration stations (NOAA, 2017) and the South Coast AQMD Hudson Air Monitoring Station.

South Coast AQMD staff conducted a comprehensive analysis of available meteorological data for this region, which included:

- A multi-year (2016 - 2018) wind data analysis from meteorological stations located at Los Angeles Airport, South Coast AQMD Hudson Station and NOAA Station PFXC1 (See Appendix section A1-a); and

- Vertical wind profiles analysis utilizing available data from a wind profiling Lidar (Leosphere WindCube) operated by the South Coast AQMD since 2016 (See Appendix section A1).

Typical wind patterns for this region are summarized by the wind roses in Figure 4 and are described in more detail in Appendix A1. Wind conditions in this region vary widely and refinery emissions can potentially impact most of the surrounding communities. Therefore, the locations of potential community air monitoring sites were identified with the goal of being distributed as evenly as possible around the refineries to reflect the broad range of wind conditions present in this region. During initial field surveys, South Coast AQMD staff identified twenty five potential sites suitable for establishing community air monitoring stations. These potential site locations are shown in Figure 4.

2.1.1.2 Torrance Community (Region 2)

Region 2 includes the Torrance Refining Company and the nearest surrounding communities within the City of Torrance (Figure 5). The closest residential area is north of the refinery, while the areas immediately to the east, west and south of the Torrance facility are mostly commercial. There are numerous parks, schools and businesses throughout all of these communities.

Thirteen potential community air quality monitoring site locations were identified in this Region (Figure 5). Eleven of these are in the community that borders the northern refinery fenceline. This area is expected to be frequently impacted by refinery emissions based on the predominant wind directions (see Figure 3a in Appendix A1-c). Two of these potential sites are in communities to the west and south of the refinery (Table 3a).

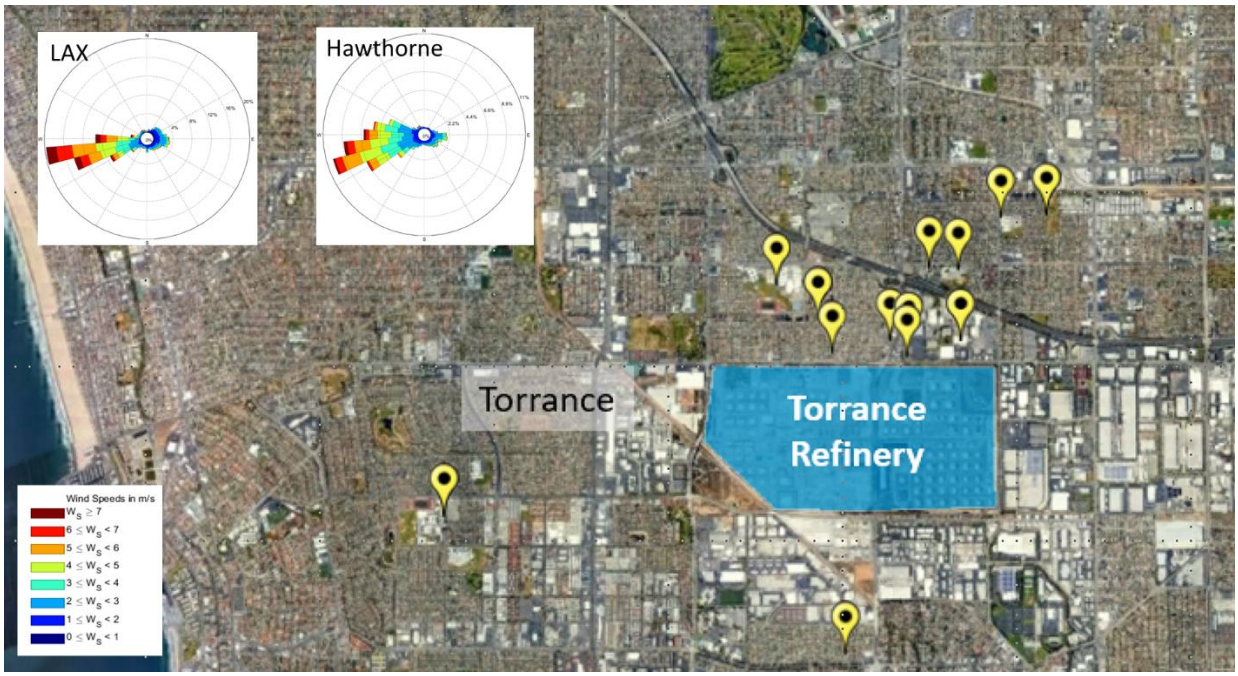

Figure 5: Satellite image of the areas surrounding the Torrance refinery (Region 2). Yellow markers indicate the location of potential community monitoring sites.

As a result of violations related to the Torrance Refinery explosion in February 2015 and to the Fluid Catalytic Cracking Unit (FCCU) start-up activities of the Torrance Refinery, ExxonMobil entered into a settlement agreement with the South Coast AQMD. A Request for Proposals was prepared and released to solicit proposals for projects benefiting the community and using Supplemental Environmental Project (SEP) funds received from the settlement. On July 7, 2017, the South Coast AQMD Governing Board approved contracts with the City of Torrance and Sonoma Technology, Inc. (STI) for the implementation of two Supplemental Environmental Projects (SEP): one to enhance the monitoring and alert system at the Torrance Refinery (awarded to STI); and one to provide warnings and updates to Torrance residents during refinery flaring and emergencies (awarded to the City of Torrance). Under this SEP, starting November 2019, STI will operate three temporary community air monitoring sites for two years. Community air monitoring sites operated by STI will monitor for selected Rule 1180 compounds (hydrogen fluoride, benzene, toluene, xylenes, and hydrogen sulfide). During these two years of SEP monitoring, South Coast AQMD will augment air monitoring at one of the SEP community stations to measure additional Rule 1180 compounds. Upon the completion of this SEP project, the South Coast AQMD will take over one of these SEP locations to conduct permanent Rule 1180 community air monitoring.

The Torrance Refinery is one of the two refineries in the Basin that uses modified hydrogen fluoride (HF) as part of its operations. Ambient concentrations will be continuously monitored at all community air monitoring stations operated by the South Coast AQMD and STI around the Torrance Refinery using real-time instrumentation capable of detecting very low HF concentrations (see Table 4 for instrument specifications).

2.1.1.3 El Segundo, Manhattan Beach, Hawthorne and Del Aire Communities (Region 3)

Region 3 includes the Chevron-El Segundo refinery and surrounding communities. The refinery is surrounded by residential communities on three sides, El Segundo to the North and East, and Manhattan Beach to the South and South-West. The area directly east of the refinery fenceline is mostly commercial and extends 1,500 m (4,900 ft) east to Del Aire and Hawthorne (Figure 6). Santa Monica Bay is to the west of the refinery, with El Segundo and Scattergood power plants situated between the refinery and the Pacific Ocean, and Hyperion Water Treatment plant directly North West of the refinery.

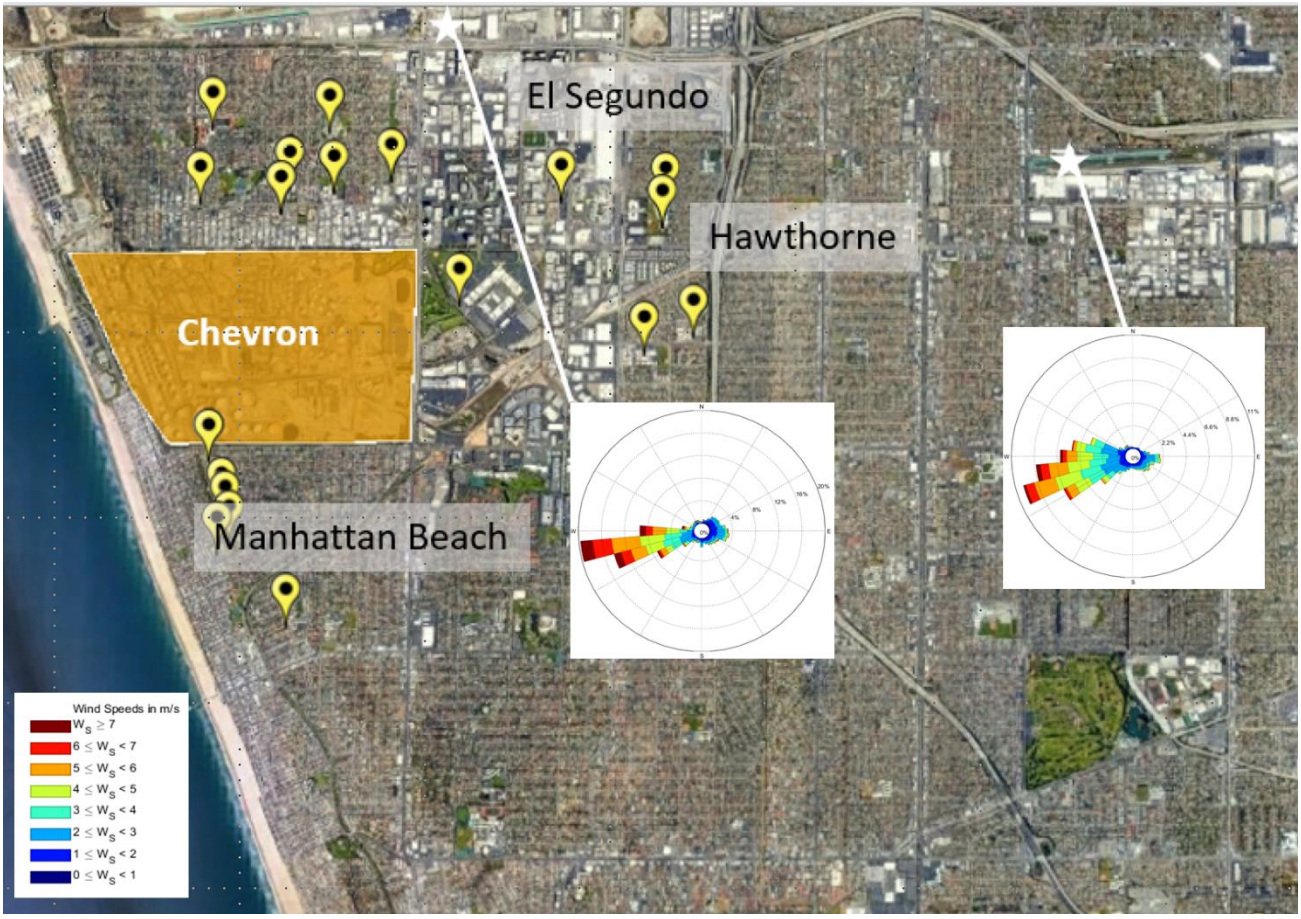

Figure 6 Satellite image of the areas surrounding the Chevron El Segundo refinery (Region 3). Yellow markers indicate the location of potential community monitoring sites.

The City of El Segundo is primarily a residential area with a thin band (~1 block width) of commercial buildings along the northern refinery fenceline. Considering the predominant wind directions, the east most section of this region is the most likely to be impacted by emissions from the refinery.

Manhattan Beach, which is south of the refinery, is mostly residential, with few locations available for community monitoring. This area is frequently up-wind of the refinery, and a community air monitoring station placed in this area would likely be measuring background levels of air pollutants most of the time.

The Del Aire and Hawthorne communities are east of this region and are separated from the refinery by industrial, commercial, and office buildings directly adjacent to the Chevron facility.

Thirteen potentially suitable community air monitoring site locations were identified within the communities surrounding the Chevron refinery (see Figure 6 and Appendix A1). In case of a leak or other unplanned fugitive emission events, the sites located in the communities of Hawthorne

and Del Aire may be impacted the most because wind directions in this region occur mostly from the West). However, these potential site locations are farther away from the refinery compared to those in Manhattan Beach and El Segundo, which are much closer to the Chevron facility.

2.1.2 Multi-pollutant Monitoring

Petroleum refineries and related activities have the potential to emit a wide range of air contaminants, including:

- VOCs and photochemically reactive species that contribute to the formation of tropospheric ozone (e.g., ethylbenzene and formaldehyde);
- Carcinogenic air pollutants (e.g., benzene, 1,3-butadiene, naphthalene, polycyclic aromatic hydrocarbons, formaldehyde);
- Non-carcinogenic hazardous air pollutants (e.g. hydrogen fluoride and hydrogen cyanide)
- Chemicals that can cause odors (e.g. hydrogen sulfide);
- Criteria pollutants (e.g., NOx and SO_2); and
- Particulate matter and black carbon (e.g. flaring events and diesel traffic associated with refinery operations, respectively)

During the Rule 1180 rule-making process a comprehensive list of chemicals to be monitored by the refinery fenceline air monitoring systems was created. All air pollutants on the refinery fenceline Rule 1180 list (identified in Table 3, and described in detail in Appendix A2) would be measured at all Rule 1180 community air monitoring stations. Additional pollutants may also be monitored, if necessary, based on information from other available air pollution measurements (e.g. South Coast AQMD MATES and other special studies). Multiple monitoring technologies would be required to ensure adequate compound identification at the appropriate levels of detection and accuracy, and with the desired time resolution.

Table 3: Rule 1180 air pollutants

Air Pollutants
Volatile Organic Compounds
Total VOCs (Non-Methane Hydrocarbons)
Formaldehyde
Acetaldehyde
Acrolein
1,3-Butadiene
Styrene
BTEX (Benzene, Toluene, Ethylbenzene, Xylene)
Other Compounds
Hydrogen Sulfide
Ammonia
Black Carbon
Hydrogen Fluoride (if facility uses hydrogen fluoride)

Hydrogen Cyanide
Criteria Air Pollutants
Sulfur Dioxide
Nitrogen Oxides

2.1.2.1 Air Monitoring Equipment and Methods Selection

The selection of the instrumentation for the air monitoring stations is driven by the requirement to provide near real-time air pollution information and notification as well as detection limits for long-term characterization of pollutants. One of the main requirements of Rule 1180 is to measure and report air pollution levels in near real-time. Such short-term monitoring is necessary to evaluate the immediate impact of fugitive emissions (e.g. leaks) and other releases in the surrounding communities. Thus, instrumentation should have sufficient time resolution to characterize pollution levels changing on short time scales (e.g. minutes). Community air monitoring should also be able to characterize the variability of typical levels of pollutants on longer time scales (diurnal, seasonal, annual) in various locations that likely would represent local background levels. Such long-term monitoring is important to assess potential air quality impacts of refinery emissions over time. Thus, the sensitivity of the instrumentation should be sufficient to measure typical background concentrations of air pollutants.

In order to satisfy the objectives of Rule 1180 community air monitoring, South Coast AQMD staff will use a combination of traditional and advanced air monitoring technology, utilizing the most appropriate instruments and methods for the given monitoring objective. These will include air monitoring equipment that is already being used for air quality monitoring at other South Coast AQMD air monitoring stations (e.g., Federal Reference or Federal Equivalent Methods; FRM and FEM, respectively) or other appropriate technology if FRM/FEM equipment for a particular pollutant (or set of pollutants) does not exist (e.g. ORS and other state-of-the-art technology). Continuous and real- (or near real-) time instruments will be utilized if suitable technology is commercially available. The selected instruments will also have detection limits low enough to measure typical ambient variation of the targeted pollutants in an urban environment. Air monitoring equipment capable of measuring a number of desired compounds simultaneously with appropriate accuracy and precision is preferable to satisfy cost and space limitations. Overall, appropriate technology for the intended purpose will be used to monitor the suite of pollutants identified in the previous section in all Rule 1180 communities. Below is an in depth description of the main air monitoring equipment that will be used in Rule 1180 community air monitoring stations, along with considerations regarding the use and application of each technology.

The following factors were considered in the community air monitoring instrument selection process:

- Instrument performance (e.g. minimum detection limits, accuracy, precision, other);
- Measurement time resolution (continuous instruments with a time resolution of at least five minutes, if available);
- Multi-pollutant detection capabilities;
- Experience and reliability of the manufacturer;
- Consistency and comparability with other relevant and related monitoring programs (e.g. instrumentation that is already used in other South Coast AQMD monitoring programs, if appropriate; or deploying similar type of equipment);
- Calibration schedule and requirements (e.g. how often calibrations need to be performed, and what calibration equipment is required) ;
- Possible interferences from other local pollutants or environmental conditions (e.g. can instrument performance be affected by environmental conditions such as high relative humidity or high PM loadings);
- Maintenance schedule and down-time (how often instrument maintenance has to be performed, and how long instrument would be off-line);
- Availability of spare parts;
- Cost of the instrumentation;
- Operational costs;
- Longevity of the equipment;
- Safety (e.g. are there safety concerns or personal protective equipment (PPE) requirements for station operators);
- Procurement lead-time;
- Software integration capabilities and software compatibility;
- Data output capability including format and processing;
- Level of expertise required to operate the instrument; and
- Size, weight, and energy consumption

Optical air monitoring technologies, including Extractive FTIR and UV-DOAS, Chemiluminescence, and off-axis integrated cavity output spectroscopy have been selected for continuous, real-time, high frequency measurements of Rule 1180 compounds (Table 4). These technologies use similar technology selected for fenceline air monitoring by all refineries, therefore providing comparability between community and fenceline air quality measurements. In addition, automated Gas Chromatography (GC) measurements were also added to the suite of Rule 1180 community monitoring technologies. Automated GC measurements provide coarser time resolution than optical technologies (approximately one hour for GC vs five minutes for extractive FTIR and UV-DOAS), but enable better detection limits (i.e., sub-ppb) for benzene, acrolein and other important air toxic pollutants. Other instruments may be selected/added in the future if their accuracy, precision, time resolution, detection limit and overall performance are found to be superior to those of the methods listed below.

All Rule 1180 community air monitoring stations will also be equipped with meteorological instruments for measuring wind speed and direction, temperature, pressure, and relative humidity. Meteorological information will be used to identify potential sources of air pollution (e.g., refinery and/or other sources), should elevated levels be measured at the community sites.

Table 4: Technologies Selected for Community Monitoring

Pollutant	Instrument	Method	Data acquisition	Detection limit
Black Carbon (BC)	McGee Scientific AE33 Aethalometer	Attenuation of a beam of light transmitted through the filter	Continuous, real-time 5 min	0.1 µg/m3
VOCs (including BTEX)	Automated Field Gas chromatography (amnufacturer and model are TBD)	Gas Chromatography (GC)	Continuous, real-time, ~1hr	< 0.1 ppb (most compounds)
VOCs (including BTEX and other air toxics)	Summa canister sampling triggered when auto-GC measures levels above a pre-determined threshold	Laboratory analysis using gas chromatography-mass spectrometry (GC-MS) and flame ionization detection (FID)	Event-specific	sub-ppb
UV-DOAS Continuous optical multi-pollutant analyzers (BTEX, SO_2, HCHO)	Extractive UV-DOAS white cell (110 m effective pathlength)	Differential Optical Absorption Spectroscopy (DOAS)	Continuous, real-time, 3-5 minutes	0.5 ppb (benzene and xylenes) 2ppb (toluene and SO_2)
FTIR Continuous optical multi-pollutant analyzers (1,3-butadiene, acetaldehyde, acrolein, ammonia, hydrogen cyanide, hydrogen fluoride, total VOC's)	Extractive FTIR white cell (110 m effective pathlength)	Fourier Transform Infrared Spectroscopy (FTIR)	Continuous, real-time, 3-5 minutes	0.5-1 ppb (HF and N_2O) 1-3 ppb (HCN, HCHO, and NH_3) 5-8 ppb (1,3 butadiene) 10-15 ppb (acrolein, acetaldehyde and NO_2)

Hydrogen Sulfide (H_2S) and Hydrogen Fluoride (HF) (for refineries with HF)	Los Gatos Research G2205	Off-axis integrated cavity output spectroscopy (OA-ICOS)	Continuous, real-time, ~1min	~2 ppb (H_2S) < 1ppb (HF)
Hydrogen Sulfide (H_2S) and Sulfur Dioxide (SO_2) (for refineries without HF)	Teledyne T101	Chemiluminescence or pulsed fluorescence	Continuous, real-time, few minutes	~2ppb (H_2S) 0.05 ppb (SO_2)
Meteorology	Met station	Sensors for wind speed, wind direction, T, RH	Continuous, real-time, <1min	

2.2 Data Visualization, Analysis and Reporting

A comprehensive data platform to acquire, validate, visualize and analyze air measurement data will be capable of gathering and organizing data from the various air pollution measurement equipment deployed at the community sites. Data from other relevant fixed stations that are part of South Coast AQMD's air monitoring network, from mobile monitoring platforms deployed as part of AB 617, from low-cost sensor networks developed as part of Air Quality Sensor Performance Evaluation Center (AQ-SPEC), and from other equipment operated by the South Coast AQMD in Rule 1180 communities will also be added to the database to augment information about local air quality. In addition, as Rule 1180 implementation progresses, data from the refinery fenceline air monitoring systems will also be added to this data platform.

Overall, the primary goal of this newly developed data platform is to share the monitoring data with the community to the extent feasible and as quickly as possible, so that the public can better evaluate and assess potential impacts of refinery emissions in the community. It is therefore essential that the collected data is available and displayed online in near real-time, and in a user-friendly manner.

All monitoring data from the data platform will be displayed and made available on a dedicated Rule 1180 community monitoring website. The website will be a key mechanism for delivering air quality data and information to the public. The website will also be a valuable resource for community education on the potential impacts of refinery emissions and other types of air pollution. The blueprint for planned data reporting is outlined in Section 2.3 (Public Notification) and 2.4 (Public Education). For continuous monitors, pollutant concentration data will be displayed in near-real-time along with wind speed and wind direction. Time-averaged data (1-hr and 24-hr averages) will also be provided. Additionally, monitoring data will be put into context, when appropriate, with Basin average and background concentrations, National and/or

California Ambient Air Quality Standards (NAAQS and CAAQS, respectively), OEHHA RELs, and long-term pollution trends. All community monitoring data will be presented with appropriate information to indicate data quality (e.g. valid, invalid, calibration, below detection limit, etc.).

2.3 Public Notification

One of the main objectives of Rule 1180 is to provide the public with information about the potential impact of refinery emissions on air quality of local communities. Public notification is therefore desired as a means of notifying the community when and if local air quality exceeds a pre-determined acute health-based threshold.

A number of air quality standards and exposure benchmarks have been established by various regulatory agencies for both criteria and air toxic pollutants. While preparing this community air monitoring plan, South Coast AQMD staff conducted a review of available air quality standards and exposure benchmarks that have been established by various regulatory agencies for Rule 1180 pollutants. The following health-based thresholds were included in the review:

- Acute 1-hour, 8-hour and chronic relative exposure limits (REL) established by the Office of Environmental Health Hazard Assessment (OEHHA) (OEHHA, 2016);
- Average 1-hour, 24-hour and annual California Ambient Air Quality Standards (CAAQS) (CARB);
- Primary (1-hr) and secondary National Ambient Air Quality Standards (NAAQS) (U.S. EPA, a);
- 10-min and 1-hour Acute Exposure Guideline Levels for Airborne Chemicals (AEGL) (U.S. EPA, b);
- Emergency Response Planning Guidelines (ERPGs) (AIHA, 2016); and
- Immediately Dangerous to Life and Health (IDLH) levels (NIOSH, 1994)

Additional details on public notification including a detailed description on these health-based thresholds can be found in the "South Coast Rule 1180 Refinery Fenceline Air Monitoring Notification Guideline" document (see Appendix B).

In order to provide the community with the earliest notification possible on relevant changes in air quality, the Rule 1180 notification thresholds will be based on the lowest available air quality standard or health based threshold, with the shortest averaging time. This threshold was based on the desire to use the lowest tolerance limit in order to (a) allow for the early detection of hazardous compounds in communities around refineries; and (b) advise the public of potential harmful pollutants that may be present in the community. Following this approach Rule 1180 1-hour notification thresholds for each Rule 1180 compound will be based on 1-hour NAAQS, CAAQS or acute 1-hour OEHHA REL, whichever is lower (Table 5).

Table 5: Summary of the public notification thresholds for the community air monitoring for Rule 1180, highlighted in red. Some values have been rounded.

Compound	NAAQS 1-hr (ppb)	CAAQS 1-hour (ppb)	OEHHA Acute 1-hour (ppb)
Sulfur Dioxide	**75**	250	256
Nitrogen Dioxide	**100**	180	254
Formaldehyde			**45.5**
Acetaldehyde			**265**
Acrolein			**1.1**
1,3-Butadiene			**303**
Styrene			**5,000**
Benzene			**8.6**
Toluene			**9,964**
Ethylbenzene			
Hydrogen Sulfide		**30**	**30**
Carbonyl Sulfide			**273**
Ammonia			**4,662**
Hydrogen Cyanide			**312**
Hydrogen Fluoride			**298**
m-Xylene			**5,142**
o-Xylene			**5,142**
p-Xylene			**5,142**

An established OEHAA acute 1-hr REL level for ethylbenzene does not exist, therefore, no notification threshold for this pollutant will be set when community air monitoring begins. Instead, data obtained during the first 6 months of operation will be analyzed for correlations between ethylbenzene and other measured pollutants. Based on the results of this analysis, a notification threshold for ethylbenzene will then be established.

Currently, there are no health based exposure limits for black carbon (BC) and thus a notification threshold for BC will not be set. However, the spatial and temporal distribution of BC in the Basin has been studied extensively during MATES IV and South Coast AQMD staff averaged BC levels at multiple monitoring stations in order to establish regional variability of BC (Table 6). Information on BC levels in the South Coast Basin will be provided on the Rule 1180 air monitoring website. This will inform the public of how instantaneous BC concentrations at the fenceline compare with the BC levels that have been observed in their community.

Table 6: Ambient Black Carbon concentrations observed at selected sites during MATES IV. Percentage (%) values represent 5th, 25th, 75th, and 95th percentile concentrations for each site.

	Anaheim (mg/m^3)	Burbank (mg/m^3)	Central Los Angeles (mg/m^3)	Compton (mg/m^3)	Huntington Park (mg/m^3)	North Long Beach* (mg/m^3)	West Long Beach# (mg/m^3)	LA Basin (mg/m^3)
Study Average	0.92	1.33	1.49	1.14	1.26	0.96	1.45	1.29
5%	0.16	0.23	0.19	0.16	-0.04	0.16	0.21	0.16
25%	0.33	0.54	0.53	0.33	0.28	0.32	0.50	0.43
75%	1.15	1.75	2.03	1.28	1.59	1.14	1.70	1.66
95%	2.99	3.71	4.28	3.98	4.42	3.14	4.71	3.94

*MATES IV North Long Beach Station is currently designated as Long Beach
#MATES IV West Long Beach Station is currently designated as Hudson

Similarly, there are no recommended exposure limits for total non-methane hydrocarbons, and as a result, a notification threshold for total VOCs will not be initially set. The data recorded by the community air monitors after 6 months of operation will be analyzed and a typical range for total VOC (e.g. 5th and 95th percentiles and average) will be established and displayed on the website. Such reference range will be updated annually with air monitoring data from the last three years of observations as additional measurements are collected.

A running hourly-averaged concentration updated every 5 minutes will be calculated for each pollutant measured at Rule 1180 community air monitoring stations. An initial notification will be issued at the time when the hourly running average concentration of one or more Rule 1180 pollutants exceeds the recommended threshold for that pollutant (or series of pollutants) at any of the community air monitoring stations. A follow-up notification will be issued when the running averaged community concentrations fall below the threshold. While issuing a notification is recommended when ambient levels of Rule 1180 compounds are above the OEHAA Acute 1-hr REL exposure limits, it is useful to also inform the public if measured concentrations exceed other more critical reference values (e.g. AEGL). Notifications will include at a minimum the following information:

- Name of the pollutant(s) hourly average value at the time of the notification;
- Definition of the threshold;
- Identification of the community where the pollution is occurring;
- Predominant wind direction at the time;
- Identification of the nearest upwind refinery; and
- Web-links to community and refinery fenceline data

Community members and other interested parties will be able to sign up for notifications by visiting the Rule 1180 community air monitoring webpages, when they become available in 2020.

South Coast AQMD staff will send an email update to the Rule 1180 notification list (which currently contains over 4,000 subscribers) with instructions on how to subscribe to Rule 1180 air quality notifications.

2.4 Public Education

Continuous public education will be one of the cornerstones of this community monitoring program. Educational material will be developed and shared with the public to increase awareness of the potential impact that air pollution can have. Educational efforts will include the following activities:

- Dissemination of air quality data measured in the community and of other relevant information via dedicated Rule 1180 community air monitoring website. This website will display the following:
    - Near real-time (5-min) and time-averaged (1-hour and 24-hour rolling averages);
    - Contextual information for understanding the concentrations of measured pollutants;
    - Links to related measurement activities and air quality data (e.g., from the closest South Coast AQMD network station(s) and from related AB 617 projects);
    - Data quality metrics and data summaries;
    - Contact information for key South Coast AQMD personnel
- Education of community members on air quality in general, refinery emissions, and the relationships between poor air quality and health effects. Educational materials will be developed based on feedback from the community and stakeholders, and will include the following:
    - A section for comments and Frequently Asked Questions (FAQ);
    - A description of measured pollutants and measurement techniques;
    - A discussion of typical background concentrations of the pollutants of interest;
    - A discussion of the concentration levels for Rule 1180 pollutants that can cause health concerns;
    - A description of QA/QC procedures and explanations for all data quality flags;
    - A discussion of non-refinery sources in the area that may contribute to the measured pollutant concentrations (e.g., nearby freeways and truck traffic)

In addition, the website will provide links to the fenceline monitoring pages for each refinery and offer guidelines for comparison between concentrations observed at the fenceline and in the community.

All information will be presented visually using graphics and flow charts for ease of understanding, when appropriate. Links to additional resources for members of the public who wish to further educate themselves will also be provided. Additionally, the website will have a FAQ section, which will be expanded and updated over time.

South Coast AQMD staff will also use existing resources to share information on previous related experiences. For example, two research projects currently led by South Coast AQMD staff, U.S. EPA STAR (www.aqmd.gov/aq-spec/research-projects) and NASA ROSES (aqcitizenscience.rti.org/#/) have a strong focus on community air quality education through deployments of low-cost air quality sensors. South Coast AQMD staff will incorporate information gained and materials developed for these two projects in educational materials.

South Coast AQMD staff will also conduct outreach activities to inform the public, stakeholders, and other interested parties on the goals and objectives of the Rule 1180 community air monitoring program. Prior to starting monitoring, outreach activities will include holding a community meeting to present community air monitoring concepts and this Rule 1180 CAMP to the public and solicit feedback. South Coast AQMD maintains an extensive e-mail subscription list of individuals interested in Rule 1180, which consists of over 4,000 subscribers at the time of this writing. Upcoming meetings, availability of the CAMP for public review, other Rule 1180 updates, and milestones will be announced via email to all interested parties, and posted on the South Coast AQMD website.

3 Back-up Community Monitoring

Back-up monitoring will be implemented in case some or all community air monitoring equipment becomes inoperable for extended amounts of time due to malfunctions, extensive repairs, power outages, or other unforeseen events. During these unplanned situations, the temporary backup monitoring strategies listed below will be used by South Coast AQMD staff.

Instrumentation malfunctions: South Coast AQMD will purchase back-up UV-DOAS and FTIR multi-pollutant and BC analyzers (one of each), and the following precautions will be taken in case of instrument malfunction.

- 24-hour integrated VOC canister samples will be collected if any of the automated GC instruments go offline for longer than 24 hours. These samples will then be analyzed at South Coast AQMD;
- In the event of malfunctioning H_2S and/or HF point monitors, UV-DOAS and FTIR multi-analyzers also are able to measure H2S and HF. The UV-DOAS and FTIR data will be displayed until point monitors are repaired/replaced. Note that UV-DOAS and FTIR multi-analyzers will not normally be configured to report H_2S and HF because the detection capability of point monitors is better than UV-DOAS and FTIR. These measurements have sufficient sensitivity to alert for elevated levels of these compounds in a backup capacity;
- In the event of malfunctioning BC analyzers, South Coast AQMD will deploy portable mini-aethalometers, if available, or collect 24-hour integrated quartz filter samples on a one-in-three day schedule and analyze them for elemental carbon (EC is closely related to BC) in the lab.

- South Coast AQMD will maintain an approximate 3-month supply of consumables for all air monitoring equipment to ensure uninterrupted station operations

Power interruptions: Electrical work at all community air monitoring sites will be conducted by experienced and licensed contractors, and in accordance with all required specifications, regulations, and permits. Sufficient electrical power will be provided for stable operation of all air monitoring equipment and to maintain necessary climate control inside the stations. All community air monitoring stations will be equipped with uninterrupted power supplies (UPS) to ensure that station operation is not affected by small grid power fluctuations and short-term power outages. South Coast AQMD's mobile measurement platforms will be used for temporary mobile community monitoring in case of extensive power outage.

Network interruptions: In the event of network interruptions that would prevent continuous data transfer from the sites to the data platform, on-site data loggers will archive the data generated at the station until the network services are restored. Should a network interruption or malfunction last for an extended period of time, data would be uploaded into the data platform manually on a daily basis.

4 Community and Stakeholder Engagement

Community and stakeholder engagement is essential for providing ideas and feedback on community monitoring and, thus, for the successful implementation of this CAMP. Members of each community have unique knowledge of, and relationship with, the area they live in. Thus, the information provided through public participation will offer valuable insights to be considered in the site(s) selection process.

During the initial development of this draft CAMP, South Coast AQMD held two community meetings in June 2019, during which the main concepts of the plan were presented and feedback on potential locations for community monitoring was solicited. This draft plan will also be provided during public comment period in order to obtain additional feedback with respect to important design elements, such as:

- Locations of the community monitoring sites;
- Integration of Rule 1180 community air monitoring network data with other existing air quality information (e.g. data provided by existing South Coast AQMD air monitoring network; AB 617 monitoring; other);
- Attributes of the public notification system; and
- Dissemination and presentation of the monitoring data to the public

Feedback provided by community members will be considered for inclusion in the final design and implementation of this CAMP. Community input and feedback will continue to be incorporated as the program evolves.

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Appendices

A1. Wind Velocity Analysis

1. Variability in Wind Velocity by Region and Time

Wind speed and direction is expected to play a major role in determining what communities are likely to be frequently impacted by refinery emissions. To explore this, wind velocity data from Los Angeles Airport (LAX), South Coast AQMD Hudson Station and NOAA station PFXC1 for the years 2016-2018 were used to generate wind-rose type plots (Figure 1a). There are two major conclusions from this analysis. First, there is a large variation in wind direction among the three stations. This is likely a reflection of the topographical features present in the wind basin that act to disturb/deflect wind trajectories, namely Pales Verdes and Signal Hill. In addition, the orientation of the coastline near the Chevron and Torrance refineries is significantly different from the orientation of the coast near the Long Beach, Wilmington, Carson refineries. This possibly plays a role determining the direction of the daily sea-breeze that is common to coastal areas.

The second conclusion from the wind analysis is there is little variation in wind velocities from year to year at each wind station. Thus, we can expect the wind velocity data from one year to accurately represent the wind patterns as a whole for a particular area.

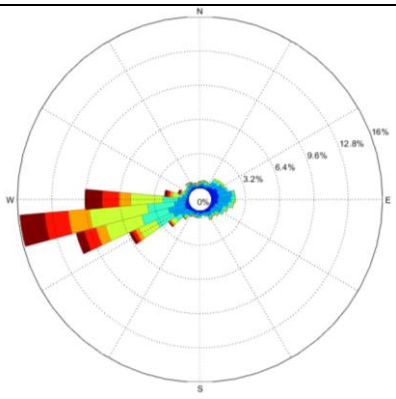
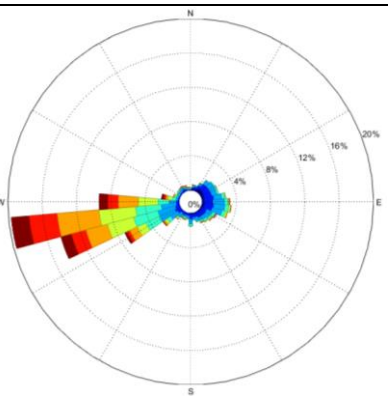
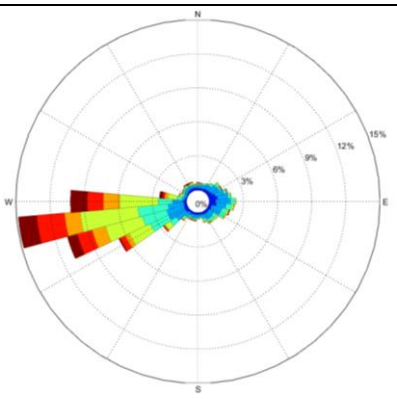
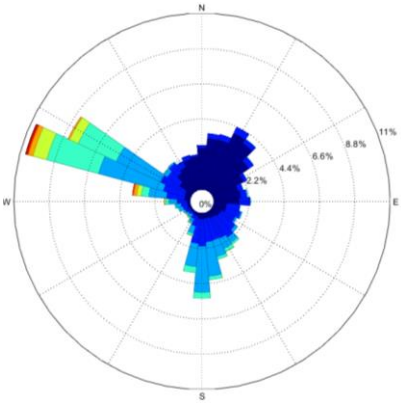
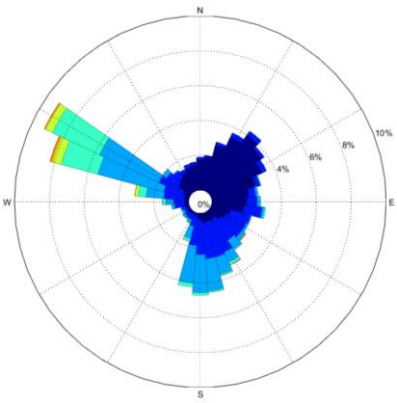
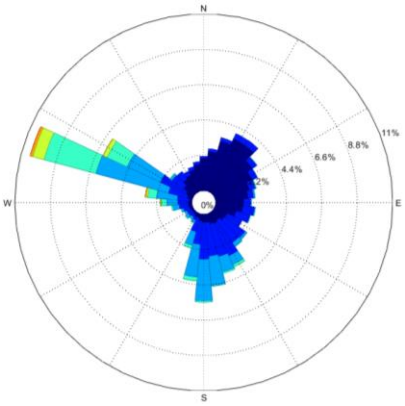
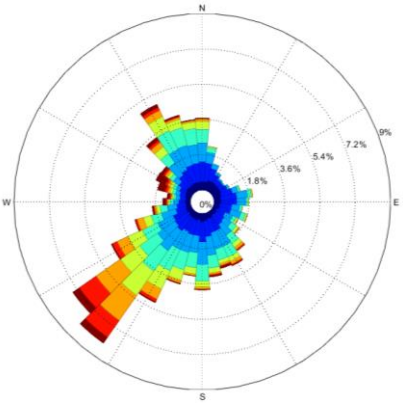
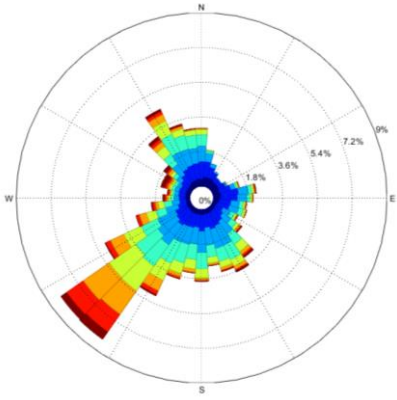
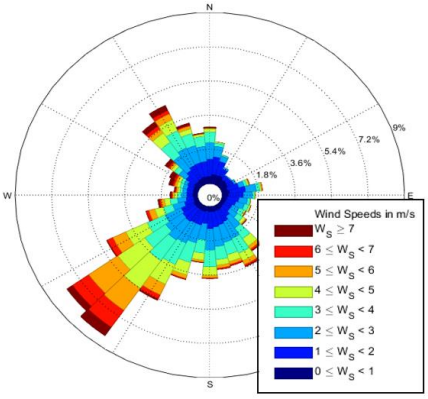
Station	2016	2017	2018
LAX			
Hudson Station			
PFXC1			

Figure 1a: Yearly wind rose plots generated from data taken from wind stations at LAX airport, South Coast AQMD Hudson Station, and NOAA station PFXC1. Data were downloaded for years 2016-2018.

2. Wind Analysis for Carson, Wilmington and Long Beach

In this section we analyze data from the South Coast AQMD Hudson station located in West Long Beach, the NOAA PXAC1 station located near the Phillps-66-Wilmington refinery and NOAA PFXC1 station located near the Valero Refinery. Wind velocity data from each station for the 2017 year was downloaded and a wind rose analysis was conducted for each dataset (Figure 2a).

Wind patterns vary widely within this region, likely because the Pales Verdes hill deflects wind trajectories. The Hudson station dataset showed three prominent wind directions (Figure 2a). The strongest feature is the dominant northwesterly direction that occurs throughout the year. A northeasterly component to the wind velocities is most frequent October – March and a southerly component is most frequent during summer months (May – August).

The wind rose analysis of the data from the NOAA PXAC1 station showed the most prominent wind direction in this region is from the northwesterly direction and ranges from roughly 270°-360°. The southerly component ranges from roughly 120°-210° and is less frequent. The southerly flow is seasonal and is most frequent in June and least in December (Figure 2a).

Wind patterns at the PFXC1 station have two significant features. A strong southwesterly component and a much weaker northwesterly component.

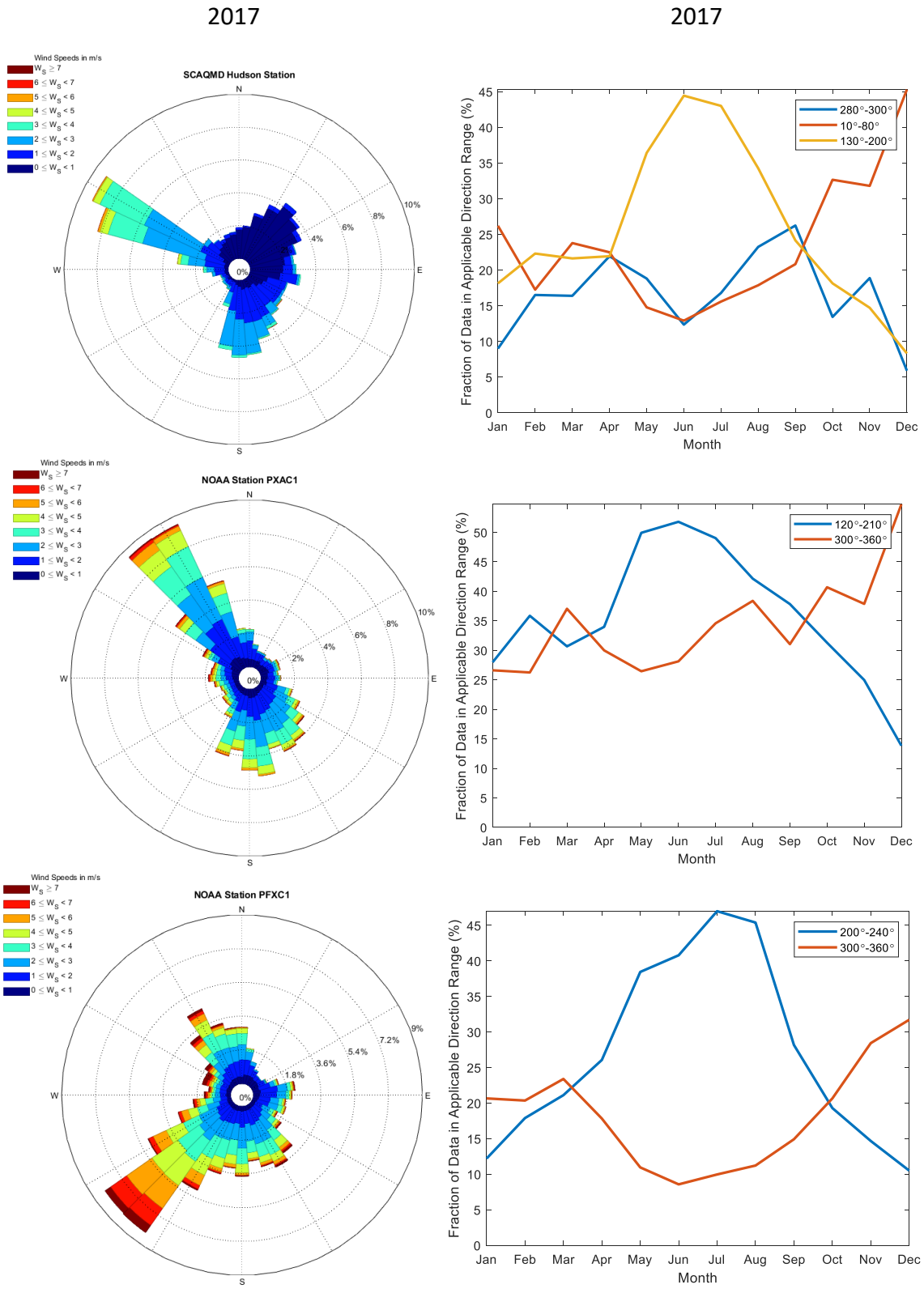


Figure 2a: Wind analysis for the South Coast AQMD Hudson Station, the NOAA PXAC1 station and the PFXC1 Station. Top Row Left-Wind rose plot for wind velocity data taken from the South Coast AQMD Hudson Station for the 2017

year. Top row right-frequency of occurrence of wind directions from various directions by month at the Hudson Station. Middle row-same as top row but using data taken from the NOAAA PXAC1 station. Bottom row-same as top row but using data taken from the NOAAA PFXC1 station.

3. Wind Analysis for El Segundo, Hawthorne, Del Aire, Manhattan Beach and Torrance

The wind patterns at LAX are dominated by a consistent sea-breeze occurring within a very narrow directional range (Figure 3a). Easterly offshore flow does occur but is much less frequent. The easterly flow is seasonal and reaches a maximum frequency of ~40 % in January.

The westerly winds at nearby Hawthorne Airport vary across a wider range compared to LAX. The Hawthorne airport is located 5 miles inland from LAX and flows are likely disrupted by surface features (buildings, trees, and hills). Generally the wind patterns at Hawthorne Airport are similar to those at LAX.

2017 2017

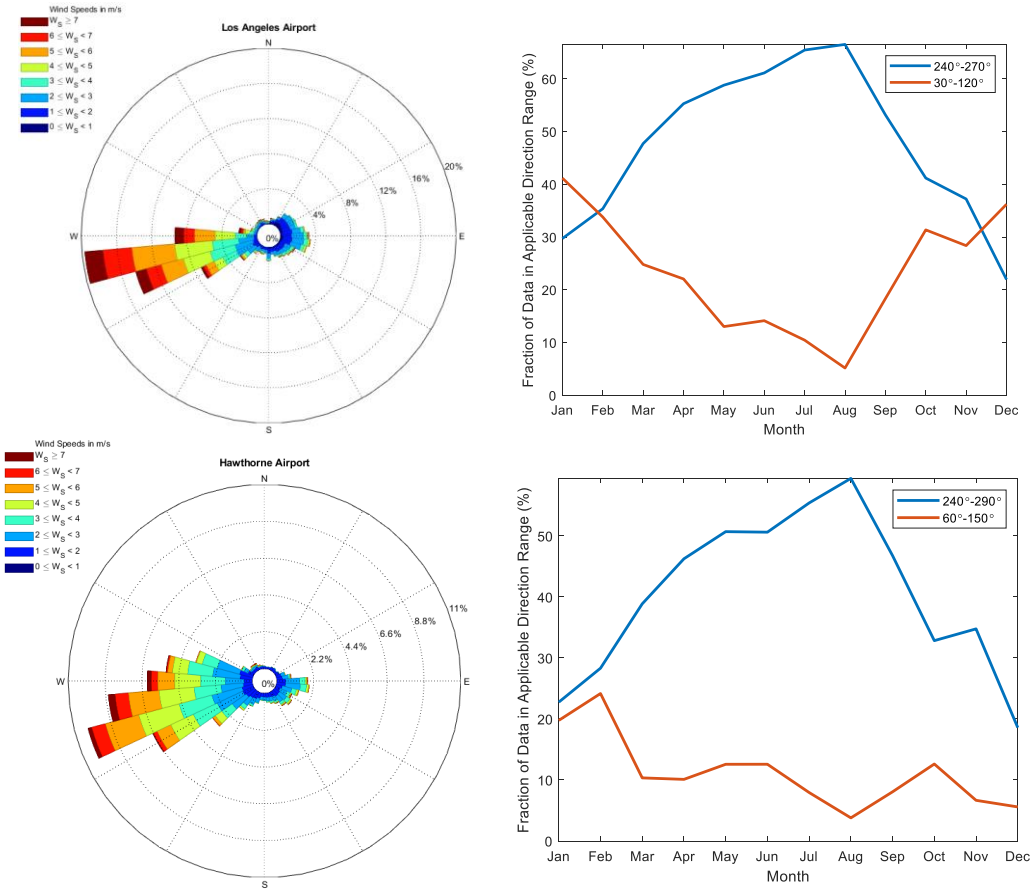


Figure 3a: Wind rose plot generated from wind velocity data collected at the Los Angeles Airport and Hawthorne Airport. Data are from the entire 2017 year and are 1-hour averages.

4. Variability in Wind Velocity with Elevation

Data from a scanning wind profiling LIDAR (Leosphere, WindCube 100s) was used to conduct an analysis wind patterns at different altitudes. For this purpose, South Coast AQMD staff deployed Leosphere wild LIDAR in Carson, CA from July 1st – July 25th, 2019. The LIDAR data were binned into four daily time intervals (night, morning, day, and evening) and 3 height intervals to generate wind rose plots for each variation (12 plots total). This approach allows for the investigation of daily wind cycles at different elevation ranges. The results of this analysis indicate the presence of a strong diurnal pattern at the low and mid elevation (Figure 4a). Wind directions at the lowest elevation range (0-300 m) were from the southeast direction from midnight through mid-day and gradually shifted to the northwesterly direction later in the day. This trend was also visible at the middle elevation range (300-700 m) however there was significant variability in wind direction from mid-day through midnight. In general the diurnal cycle is less evident and wind directions become more variable as elevation increases (bottom row). This is likely because surface temperature effects that drive diurnal flow have less impact on upper levels flows which are likely more driven by larger scale meteorological events, i.e. fronts, high/low pressure systems etc.

Overall, wind directions in this region vary widely on daily time scales and across all elevations therefore supporting the need for community air monitoring stations widely dispersed throughout communities in Carson, Wilmington and Long Beach.

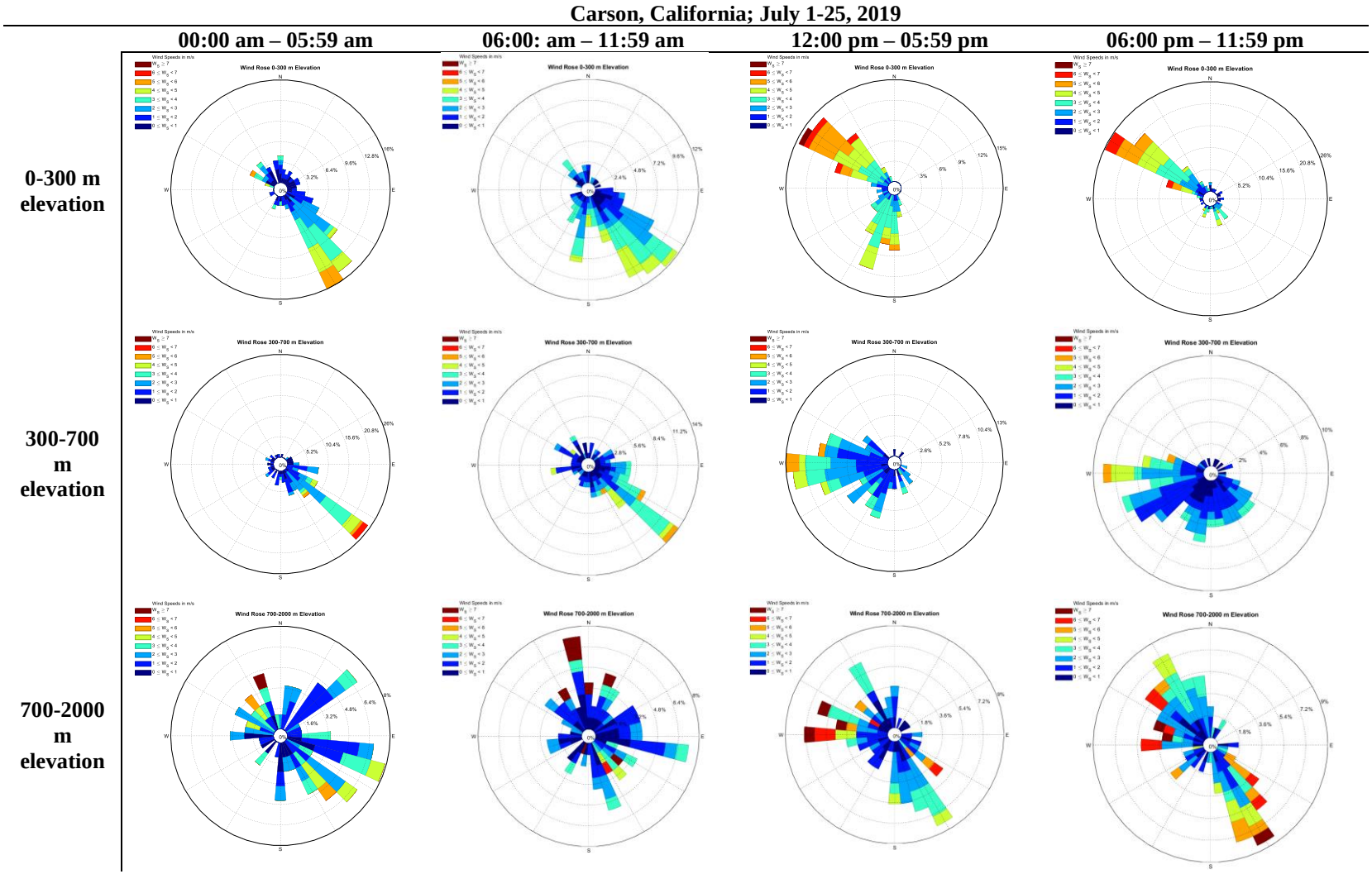


Figure 4a: Wind rose plots generated from data collected with the South Coast AQMD scanning LIDAR. The four columns indicate data collected between 00:00 am - 06:00 am, 06:00 am - 12:00 pm, 12:00 pm to 06:00 pm and 06:00 pm – 12:00 am. The three rows separate the data by elevation where the first row is 0-300 m, the second 300-700 m and the 3rd 700-2000 m. The Lidar was located at the Ventura Transfer company located in Carson, CA and the data was collected between July 1st and July 25th 2019.

A2. Description of Air Pollutants

Acetaldehyde

What is it? At room temperature acetaldehyde is a colorless liquid with a strong fruity odor.

Where does it come from at a refinery? Acetaldehyde is one of several aldehyde compounds from the incomplete combustion of natural gas and other fuels. Primarily, it is emitted from heaters and boilers fueled by natural gas.

Where else do you find it? Acetaldehyde is a product of motor vehicle exhaust, coal refining, waste processing, cigarette smoke, vaping, and coffee roasting. Acetaldehyde also is found in various plants, ripe fruits, and vegetables and is formed in the body from the breakdown of alcohol.

Why measure it? In the atmosphere, acetaldehyde contributes to the formation of ozone and other air pollutants. Residential fireplaces and woodstoves are the two highest sources of acetaldehyde emissions, followed by industrial emissions. In California, about 3 to 4% of all outdoor acetaldehyde emissions are from industrial facilities including chemical plants, refineries, power plants, and hazardous waste incinerators.

How might it affect my health? Short-term exposure to acetaldehyde can cause eye, skin or respiratory tract irritation. At high exposure levels acetaldehyde may cause skin redness, coughing, or fluid build-up in the lungs. The symptoms associated with long-term exposure to acetaldehyde include liver damage and other symptoms seen in long-term alcohol abuse. The U.S. Environmental Protection Agency (U.S. EPA) classifies acetaldehyde a probable human carcinogen based on animal studies.

What concentration of acetaldehyde is typically found in air in the South Coast Air Basin?

The average concentration of acetaldehyde found in the LA Basin was 0.86 parts per billion (ppb). Acetaldehyde concentrations ranged from 0.02 – 3.07 ppb.

Acrolein

What is it? At room temperature acrolein is a clear or yellow liquid with a burned, sweet, pungent odor.

Where does it come from at a refinery? Acrolein comes from the incomplete combustion of natural gas and other fuels that produce several aldehyde compounds, including acrolein.

Where else do you find it? Acrolein is produced when cooking oil or grease are over-heated and from vaping and burning wood or tobacco. Acrolein also is used as a pesticide and in the manufacturing of other chemicals.

Why measure it? Acrolein can be formed during the breakdown of other pollutants in air and contributes to the formation of ozone, which is a major pollutant in the LA Basin.

How might it affect my health? Short-term inhalation of acrolein may cause watery eyes or a burning sensation of the nose or throat. Exposure to higher levels of acrolein may result in respiratory congestion, and eye, nose, and throat irritation. Long-term inhalation of acrolein may damage the respiratory tract.

What concentration of acrolein is typically found in air in the South Coast Air Basin?

The population weighted annual average ambient air concentration of acrolein in 2014 was 0.68 ppb.

Ammonia

What is it? There are two forms of ammonia: its colorless gas form with a pungent odor, and its liquid form, which is known to most people for its use in many household and industrial cleaners, as well as window-cleaning products.

Where does it come from at a refinery? Ammonia primarily is used to control nitrogen oxide emissions and is part of the fluid catalytic cracking process used to turn heavy fractions of petroleum crude oil into gasoline.

Where else do you find it? There are both natural and man-made sources of ammonia. Ammonia is essential for many biological processes and has various industrial applications. Natural sources of ammonia primarily include the breakdown of animal and vegetable matter. The main commercial use of ammonia is for fertilizers; other man-made uses are in cleaning products and during the production of plastics, fibers, , nitric acid, dyes, and pharmaceuticals.

Why measure it? Ammonia is included in the chemicals to be measured in the community monitoring plan in order to assess potential community exposures and, if present, identify the source.

How might it affect my health? At levels typically found in air ammonia, its unlikely to cause health effects, but at high levels it is an irritant. At high levels ammonia may irritate the skin, eyes, throat, and lungs and may cause coughing or burns. People who have asthma or other respiratory tract problems are more sensitive to these irritant effects.

Black Carbon

What is it? Black carbon is a major component of soot, the black material produced as a result of incomplete combustion of fossil fuels, biofuels, and biomass. Black carbon in the atmosphere exists primarily as particles too small to see (about 2.5 microns or less).

Where does it come from at a refinery? The major sources of black carbon are from onsite trucks with heavy-duty diesel engines, small diesel-powered generators, and other combustion emissions.

Where else do you find it? The major source of black carbon are diesel engines in cars, trucks, trains, ships, planes, and school buses, coal-fired power plants, and combustion-related sources including fossil and biofuels. Other sources of black carbon are barbecuing/charcoaling meat and wood burning stoves.

Why measure it? Black carbon is used to estimate diesel particulate levels since diesel particulate matter cannot be measured directly. Diesel particulate emissions are the number one contributor to cancer risk in LA Basin air.

How might it affect my health? Black carbon can irritate the lungs and make respiratory illnesses such as asthma and bronchitis worse.

What concentration of black carbon is typically found in air in the South Coast Air Basin?

The average concentration of black carbon in the LA Basin was 1.28 mg/m^3. The maximum black carbon concentration reported was 26.21 mg/m^3.

BTEX

What is it? BTEX is an acronym for benzene, toluene, ethylbenzene, and xylenes which are compounds in crude oil. They are often referred to as “light ends” since they are lighter and more volatile than the heavier compounds found in crude oil like greases and tars.

Where does it come from at a refinery? The major sources of BTEX emissions are associated with the transfer, storage, and processing of crude oil and the combustion of natural gas.

Where else do you find it? There are natural and man-made sources of BTEX. These compounds primarily are released into the atmosphere from motor vehicle and aircraft emissions, wood combustion, and cigarette smoke. High levels of BTEX compounds are common on and near major roadways.

Why measure it? BTEX is found in all urban air basins; measuring it can help determine whether a refinery is a significant source of these chemicals in local outdoor air. BTEX also contributes to the formation of ozone which is one of the primary air pollutants of concern in the South Coast

Air Basin. The Los Angeles air basin has the highest levels of ozone in the country. Ozone contributes to the formation of smog.

How might it affect my health? See below for specific information about the health impacts of each BTEX compound.

Benzene

What is it? Benzene is a colorless, highly flammable liquid with a sweet gasoline odor.

Where does it come from at a refinery? Benzene is emitted from crude oil processing, storage, and the combustion of natural gas.

Where else do you find it? Benzene in the atmosphere is primarily from car emissions and gasoline vapors. It is also widely used to make other chemicals and manufacture items such as rubbers, dyes, detergents, drugs, and pesticides. Cigarette smoke is responsible for most of the benzene found in indoor environments and is a significant source of exposure to not only smokers but also to those exposed to secondhand smoke. Natural sources of benzene include volcanoes and forest fires.

Why measure it? Benzene is a cancer-causing chemical and is second only to diesel exhaust as a cancer-causing pollutant in the LA Basin. While the bulk of benzene in the air comes from vehicle exhaust, it is important to measure the concentration in ambient air to identify and control emissions from industrial sources including refineries**.**

How might it affect my health? Short-term inhalation of high levels of benzene can cause dizziness, lightheadedness, and headaches as well as lung irritation. The long-term effects of benzene exposure are related to anemia and effects on the bone marrow. Benzene is classified as a cancer-causing chemical in humans based on workers with long-term occupational exposure as well as on animal studies.

What concentration of benzene is typically found in air in the South Coast Air Basin?

The average concentration of benzene found in the LA Basin is 0.40 ppb, with concentrations ranging from 0.02 to 1.77 ppb.

Toluene

What is it? Toluene is a colorless liquid that smells like paint thinner.

Where does it come from at a refinery? Toluene is produced when making gasoline and other fuels from crude oil. A major source of toluene at a refinery is in the catalytic converter process.

Toluene emissions are associated with the transfer, storage, and processing of crude oil and the combustion of natural gas.

Where else do you find it? Toluene is used in making paints, paint thinners, nail polish, lacquers, adhesives, rubber, and in some printing and leather tanning processes. Toluene occurs naturally in crude oil and the tolu tree.

Why measure it? Toluene like the other components of BTEX (benzene, ethylbenzene and xylene) is a major contributor to ozone formation in the LA air basin.

How might it affect my health? Exposure to low to moderate levels of toluene can irritate the nose, throat and eyes, lungs, and cause headaches. Long-term daily breathing of toluene by workers has been associated with hearing and color vision loss. Toluene is the ingredient in airplane glue and paints that led to wide-spread abuse when inhaled causing nervous system damage.

What concentration of toluene is typically found in air in the South Coast Air Basin?

Toluene concentrations typically equal 1.11 ppb on average in the LA Basin. Concentrations ranged from 0.1 to 6.15 ppb.

Ethylbenzene

What is it? Ethylbenzene is a colorless liquid that smells like gasoline. It evaporates at room temperature and burns easily.

Where does it come from at a refinery? Ethylbenzene emissions are associated with the transfer, storage, and processing of crude oil and the combustion of natural gas.

Where else do you find it? Ethylbenzene in the atmosphere is primarily a result of automobile emissions. The majority of ethylbenzene is produced to make styrene in addition to fuels and solvents. It is also used in consumer products such as paints, pesticides, carpet glues, and tobacco products.

Why measure it? Like the other components of BTEX (benzene, toluene and xylene) ethylbenzene contributes to the formation of ozone.

How might it affect my health? Breathing very high levels of ethylbenzene can cause throat and eye irritation and dizziness. Breathing lower levels over long periods of time causes hearing and kidney damage in animals. The World Health Organization has identified ethylbenzene as a possible human carcinogen based on animal studies.

What concentration of ethylbenzene is typically found in air in the South Coast Air Basin?

The average concentration of ethylbenzene in the LA Basin is 0.23 ppb. The maximum concentration reported equaled 4.75 ppb.

Xylene

What is it? Xylene is a colorless, flammable liquid with a sweet odor.

Where does it come from at a refinery? Xylene emissions are associated with the transfer, storage, and processing of crude oil and the combustion of natural gas. Xylenes are also used to increase the octane of gasoline.

Where else do you find it? Xylene occurs naturally in petroleum, coal tar, and forest fires. Xylene is present in automobile exhaust and is primarily used as a solvent in the printing, rubber, and leather industries.

Why measure it? Like the other components of BTEX (benzene, toluene and ethylbenzene), xylene is a major contributor to ozone formation in the LA air basin.

How might it affect my health? Exposure to high levels of xylene for short periods of time can irritate the eyes, nose, throat, or skin. Both short- and long-term exposure to high levels of xylene may cause effects on the nervous system such as headaches, dizziness, confusion, and lack of muscle coordination.

What concentration of xylene is typically found in air in the South Coast Air Basin?

There are three forms of xylene which are measured in the LA Basin air and all function similarly. Meta- and para-xylene concentrations were on average 0.77 ppb in the LA Basin, while ortho-xylene concentrations were 0.19 ppb on average.

1,3-Butadiene

What is it? 1,3-Butadiene is a colorless gas with a mild gasoline-like odor.

Where does it come from at a refinery? 1,3-Butadiene is produced during petroleum processing.

Where else do you find it? The major source of 1,3-butadiene in the atmosphere is from motor vehicle exhaust. Other sources of 1,3-butadiene include waste incineration, wood fires, and cigarette smoke. The majority of manufactured 1,3-butadiene is used to make synthetic rubber (e.g., car and truck tires) as well as plastics including acrylics.

Why measure it? Although 1,3-butadiene breaks down quickly in the atmosphere, it is found in outdoor air at low levels in urban and suburban areas. About 53% of 1,3-butadiene emissions in

California come from on-road and off-road vehicles; less than 1% comes from point sources such as chemical plants, refineries, power plants, and hazardous waste incinerators.

How might it affect my health? Inhalation of 1,3-butadiene may cause irritation of the eyes, nose, throat, and lungs. At very high levels, neurological effects such as blurred vision, fatigue, headache, and vertigo have been reported. Breathing in 1,3-butadiene can cause cancer in humans.

What concentration of 1,3-butadiene is typically found in air in the South Coast Air Basin?

In the LA Basin, average concentrations of 1.3-butadiene equaled 0.09 ppb. Concentrations ranged from 0 to 0.58 ppb.

Carbonyl Sulfide

What is it? Carbonyl sulfide is a colorless gas with a sulfur odor.

Where does it come from at a refinery? Carbonyl sulfide comes from the process of oil refining, which may be released into the atmosphere as fugitive emissions (e.g., leaking valves or pipes).

Where else do you find it? There are natural and man-made sources of carbonyl sulfide. Natural sources of carbonyl sulfide include crude oil, volcanic gases, hot springs, marshes, and soils. Carbonyl sulfide is found in motor vehicle exhaust and tobacco smoke.

Why measure it? Carbonyl sulfide is classified as a California toxic air contaminant and a federal hazardous air pollutant.

How might it affect my health? Short-term inhalation of high levels of carbonyl sulfide may irritate the eyes and skin and may cause nervous system effects.

Formaldehyde

What is it? Formaldehyde is a colorless gas with a strong pungent odor. Everyone is exposed to small amounts of formaldehyde in air and in some foods and consumer products.

Where does it come from at a refinery? Formaldehyde comes from the incomplete combustion of natural gas and other fuels which produces several aldehyde compounds from heaters, boilers, and to a lesser extent engines and flares.

Where else do you find it? Formaldehyde in the atmosphere comes from smoke due to fires and motor vehicle exhaust. Small amounts of formaldehyde are produced during normal metabolic processes in most living things, including humans. In the home, the main exposure to

formaldehyde is from off gassing from building materials. Formaldehyde is also found in vaping, cigarette smoke and in consumer products such as cosmetics and hair straightening treatments.

Why measure it? In the atmosphere, formaldehyde contributes to the formation of ozone and other toxic air contaminants.

How might it affect my health? Formaldehyde can cause irritation of the eyes, nose, and throat and neurological effects. Formaldehyde also may increase the risk of asthma and allergic reactions. Formaldehyde is classified as a compound that can cause cancer.

What concentration of formaldehyde is typically found in air in the South Coast Air Basin?

On average, the concentration of formaldehyde measured in the LA Basin was 2.19 ppb. Concentrations ranged from 0.12 to 5.4 ppb.

Hydrogen Cyanide

What is it? Hydrogen cyanide is a colorless liquid or gas (depending on the temperature) with a bitter almond smell.

Where does it come from at a refinery? A small amount of hydrogen cyanide is emitted from the fluid catalytic cracking unit as a byproduct of the incomplete combustion of natural gas and other fuels.

Where else do you find it? The primary source of hydrogen cyanide in the air is from motor vehicle exhaust. Other emissions sources include municipal waste incinerators and cigarette smoke. Hydrogen cyanide is also used commercially to produce various chemicals and as an insecticide for fumigating enclosed spaces.

Why measure it? Hydrogen cyanide typically is a minor emission from refineries. Measurement may help determine whether an individual refinery is a significant source of potential community exposure**.**

How might it affect my health? Short-term exposure to lower levels of hydrogen cyanide can cause a variety of effects such as weakness, headache, nausea, increased rate of breathing, and eye and skin irritation. At higher levels hydrogen cyanide can interfere with the normal use of oxygen by nearly every organ in the body and can be deadly.

Hydrogen Fluoride

What is it? Hydrogen fluoride is a colorless liquid or gas (depending on the temperature) with a strong, pungent, irritating odor.

Where does it come from at a refinery? Hydrogen fluoride is used to produce high-octane gasoline at some refineries.

Where else do you find it? Hydrogen fluoride is used in the production of refrigerants, herbicides, pharmaceuticals, aluminum, plastics, electrical components, and fluorescent light bulbs.

Why measure it? In California, about 2% of hydrogen fluoride emissions are from sources such as chemical plants, refineries, power plants, and hazardous waste incinerators.

How might it affect my health? Breathing in high levels of gaseous hydrogen fluoride can cause severe irritation and fluid buildup in the lungs which can be fatal. At lower levels Irritation of the eyes, nose, and upper and lower respiratory tract, tearing of the eyes, sore throat, cough, chest tightness, and wheezing can occur.

Hydrogen Sulfide

What is it? Hydrogen sulfide is a colorless, flammable gas with a rotten egg odor. It can be smelled at very low concentrations in air, at least 1000 times below the level that would cause eye and lung irritation.

Where does it come from at a refinery? The major sources of hydrogen sulfide emissions at refineries are associated with the transfer, storage, and processing of crude oil and the combustion of natural gas.

Where else do you find it? There are natural and man-made sources of hydrogen sulfide. Natural sources of hydrogen sulfide include emissions from geothermal fields, volcanic gases, natural seepage from the ocean floor, and the breakdown of animal and plant wastes. Hydrogen sulfide is found in gas from swamps, sewers, sewage treatment facilities and landfills. Hydrogen sulfide occurs naturally in crude oil and natural gas depending on the level of sulfur in the source. Crude oil with a low concentration of sulfur is often referred to as “sweet crude”, and oil with a higher level of sulfur is known as “sour crude”.

Why measure it? Because hydrogen sulfide can be smelled at such low levels, measuring it is important to prevent community odor annoyance as well as potential health effects..

How might it affect my health? Hydrogen sulfide at high levels can cause watery eyes and/or induce symptoms related to the sense of smell including headache, nausea, or vomiting. At extremely high levels hydrogen sulfide can befatal particularly in enclosed spaces since the gas is heavier than air and interferes with the body’s ability to use of oxygen..

Nitrogen Dioxide

What is it? Nitrogen dioxide and oxides or NO_x ("knocks") are a group of gases comprised of nitrogen and oxygen in varying amounts. Nitrogen oxides are one of the two federally regulated "criteria" pollutants that are monitored as part of the community monitoring program. The two NO_x compounds of most health concern are nitrogen oxide (NO) and nitrogen dioxide (NO_2), which when released to the atmosphere combine with particles in the air to form a reddish-brown smog layer.

Where does it come from at a refinery? The major source of NO_x is the catalytic cracking unit.

Where else do you find it? The most common sources of nitrogen oxides are motor vehicle exhaust. These compounds also form from wood burning, welding, kerosene heaters and gas stoves. Nitrogen oxide and nitrogen dioxide are found in tobacco smoke.

Why measure it? Nitrogen oxides are major contributors to smog. NO_x combines with volatile organic compounds (VOCs) in the atmosphere and reacts with sunlight to form ozone and particulate matter. About 88% of nitrogen oxides in the LA air basin come from on-road and off-road vehicles combined. About 5% comes from sources including chemical plants, refineries, power plants, and hazardous waste incinerators.

How might it affect my health? Low levels of nitrogen oxides can irritate the eyes, nose, throat, and lungs, and may cause a cough, shortness of breath, tiredness and nausea. Exposure to higher levels of NO_x can damage the airway. NO_2 exposure can make allergic responses in asthmatics worse.

What concentration of nitrogen dioxide is typically found in air in the South Coast Air Basin?

The population-weighted average concentration of nitrogen dioxide in 2013 was 0.016 parts per million (ppm).

Styrene

What is it? At room temperature styrene is a colorless, oily liquid with a strong sweet odor.

Where does it come from at a refinery? Styrene is a byproduct of petroleum and natural gas processing and can be emitted from fugitive sources such as piping or valves.

Where else do you find it? There are natural and man-made sources of styrene. Low levels of styrene occur naturally in plants as well as a variety of foods such as fruits, vegetables, nuts, beverages, and meats. The major source of styrene is from manufacturing plastics and rubber. Commercial products containing styrene include insulation, fiberglass, plastic pipes, automotive parts, shoes, food containers, and carpet backing. Styrene also is present in motor vehicle exhaust and tobacco smoke.

Why measure it? Measuring styrene may help determine whether an individual refinery is a significant source of this chemical in outdoor air.

How might it affect my health? Short-term exposure to styrene may cause eye and mucous membrane irritation or gastrointestinal effects. Long-term exposure or exposure to high levels of styrene may cause central nervous system effects such as headache, fatigue, weakness, depression, nervous system effects, hearing loss, and numbness of fingers and toes. Styrene is classified as a possibly causing cancer in humans.

What concentration of styrene is typically found in air in the South Coast Air Basin?

In the LA Basin, the concentration of styrene is 0.05 ppb on average. The maximum styrene concentration equaled 0.85 ppb.

Sulfur Dioxide

What is it? Sulfur dioxide is a colorless gas with a burnt match smell. Sulfur dioxide is one of the two federally regulated "criteria" pollutants that are monitored as part of the community monitoring program. It is used as an indicator of sulfur oxides or So_x ("socks") concentrations in air.

Where does it come from at a refinery? At refineries, the major sources of sulfur dioxide are fuel-fired furnaces and boilers, fluid catalytic cracking and sulfur recovery units and flares.

Where else do you find it? There are both natural and man-made sources of sulfur dioxide. Sulfur dioxide is emitted by volcanoes and by man-made sources include burning coal and other sulfur-containing fuels. At home, sulfur dioxide comes from natural gas stoves, fireplaces, lawnmowers, barbecues, hot water heaters, and other appliances.

Why measure it? Sulfur dioxide and its reaction products contribute to smog formation. Sulfur dioxide levels in California have decreased dramatically and now are only 10% of the level measured in the 1970s.

How might it affect my health? At high levels sulfur dioxide can irritate the lungs, cause difficulty breathing, and cause burning of the nose or throat. Children, the elderly, and people, with asthma, heart disease, or chronic lung disease (such as bronchitis or emphysema) are most sensitive.

VOCs

What is it? VOCs are a class of many carbon-containing chemicals including alcohols that easily evaporate into the air. Most scents/odors are from VOCs.

Where does it come from at a refinery? At refineries, the major sources of VOCs are associated with the production of fuels, storage tanks, pipelines, and waste areas.

Where else do you find it? There are both natural and man-made sources of VOCs. VOCs are released during wildfires and man-made sources include fossil fuel combustion, motor vehicle exhaust, various industrial processes, and solvent usage. At home, VOCs may be emitted from printers and copiers, from building materials such as carpet and linoleum, and from a variety of consumer products including paints, cleaning products, cigarettes, adhesives, arts and craft supplies, candles, air fresheners, and pesticides.

Why measure it? VOCs are major contributors to smog. About 78% of VOCs in the LA air basin come from on-road and off-road vehicles or man-made products. About 6% comes from industrial sources that include chemical plants, steel mills, refineries, power plants, and hazardous waste incinerators.

How might it affect my health? The health effects of short-term exposure to various VOCs may include eye, nose and throat irritation, headaches, dizziness, and vison or memory problems. Long-term exposure to VOCs may include nausea, fatigue, loss of coordination, or damage to liver, kidney or central nervous system. Some of these compounds can cause cancer in humans or animals.

What concentrations of VOCs are typically found in air in the South Coast Air Basin?

On average, the concentration of total VOCs is 238.17 ppb, with concentrations ranging from 17.12 to 3,729.76 ppb.

Where can I learn more?

Acetaldehyde

The California EPA's Office of Environmental Health Hazard Assessment (OEHHA) has information on acetaldehyde. In addition, the U.S. EPA has an acetaldehyde "Hazard Summary" fact sheet.

Acrolein

The California EPA's OEHHA has information on acrolein (https://oehha.ca.gov/media/downloads/crnr/appendixd1final.pdf). In addition, the Centers for Disease Control and Prevention (CDC) has an acrolein "ToxFAQs" (https://www.atsdr.cdc.gov/toxfaqs/tfacts124.pdf) fact sheet.

Ammonia

The California EPA's OEHHA has information on ammonia (https://oehha.ca.gov/media/downloads/crnr/appendixd2final.pdf). In addition, the CDC has an ammonia "ToxFAQs" (https://www.atsdr.cdc.gov/toxfaqs/tfacts126.pdf) fact sheet.

Black Carbon

The U.S. EPA has information on black carbon (https://www3.epa.gov/airquality/blackcarbon/).

BTEX

The California EPA's OEHHA has information on benzene (https://oehha.ca.gov/media/downloads/crnr/appendixd1final.pdf), toluene (https://oehha.ca.gov/media/downloads/crnr/appendixd2final.pdf), and xylenes (https://oehha.ca.gov/media/downloads/crnr/appendixd2final.pdf). In addition, the CDC has "ToxFAQs" fact sheets for benzene (https://www.atsdr.cdc.gov/toxfaqs/tfacts3.pdf), toluene (https://www.atsdr.cdc.gov/toxfaqs/tfacts56.pdf), ethylbenzene, and xylenes (https://www.atsdr.cdc.gov/toxfaqs/tfacts71.pdf).

1,3-Butadiene

The California EPA's OEHHA has information on 1,3-butadiene (https://oehha.ca.gov/media/downloads/crnr/072613bentcrel.pdf). In addition, the CDC has a 1,3-butadiene "ToxFAQs" fact sheet (https://www.atsdr.cdc.gov/toxfaqs/tfacts28.pdf).

Carbonyl Sulfide

The California EPA's OEHHA has information on carbonyl sulfide (https://oehha.ca.gov/media/downloads/crnr/cosrel022117.pdf). In addition, the CDC has a carbonyl sulfide "ToxFAQs" fact sheet (https://www.atsdr.cdc.gov/toxfaqs/tfacts114-carbonyl_sulfide.pdf).

Formaldehyde

The California EPA's OEHHA has information on formaldehyde. In addition, the CDC has prepared a "ToxFAQs" fact sheet for formaldehyde.

Hydrogen Cyanide

The California EPA's OEHHA has information on hydrogen cyanide (https://oehha.ca.gov/media/downloads/crnr/appendixd2final.pdf). In addition, the CDC has a cyanide compounds "ToxFAQs" fact sheet, including hydrogen cyanide (https://www.atsdr.cdc.gov/toxfaqs/tfacts8.pdf).

Hydrogen Fluoride

The California EPA's OEHHA has information on hydrogen fluoride (https://oehha.ca.gov/media/downloads/crnr/appendixd2final.pdf). In addition, the CDC has a "ToxFAQs" fact sheet for fluorides, hydrogen fluoride, and fluorine (https://www.atsdr.cdc.gov/toxfaqs/tfacts11.pdf).

Hydrogen Sulfide

The California EPA's OEHHA has information on hydrogen sulfide (https://oehha.ca.gov/media/downloads/crnr/appendixd2final.pdf). In addition, the CDC has a hydrogen sulfide "ToxFAQs" fact sheet (https://www.atsdr.cdc.gov/toxfaqs/tfacts114.pdf).

Nitrogen Dioxide

The California EPA's OEHHA has information on nitrogen dioxide (https://oehha.ca.gov/media/downloads/crnr/appendixd2final.pdf). In addition, the CDC has a nitrogen oxides "ToxFAQs" fact sheet (https://www.atsdr.cdc.gov/toxfaqs/tfacts175.pdf).

Styrene

The California EPA's OEHHA has information on styrene https://oehha.ca.gov/media/downloads/crnr/appendixd2final.pdf (). In addition, the CDC has prepared a styrene "ToxFAQs" fact sheet (https://www.atsdr.cdc.gov/toxfaqs/tfacts53.pdf).

Sulfur Dioxide

The California EPA's OEHHA has information on sulfur dioxide (https://oehha.ca.gov/media/downloads/crnr/appendixd2final.pdf). In addition, the CDC has a sulfur dioxide "ToxFAQs" fact sheet (https://www.atsdr.cdc.gov/toxfaqs/tfacts116.pdf).

VOCs

The National Institutes of Health has prepared a "Chemicals & Contaminants" summary for VOCs (https://toxtown.nlm.nih.gov/chemicals-and-contaminants/volatile-organic-compounds-vocs#what-are-they).

Air Quality Data

The Multiple Air Toxics Exposure Study IV (MATES IV) (https://www.aqmd.gov/home/air-quality/air-quality-studies/health-studies/mates-iv) is a monitoring and evaluation study conducted in the South Coast Air Basin by South Coast AQMD.

The California EPA's OEHHA conducted a study to evaluate trends in exposure and health risk for gasoline-related air pollutants: Gasoline-Related Air Pollutants in California: Trends in Exposure and Health Risk 1996 to 2014.

Health Effects

For more information on health effects, the South Coast AQMD has prepared a document summarizing the health effects of ambient air pollutants as part of the Air Quality Management Plan.

A3. South Coast AQMD Rule 1180 Refinery Fenceline Air Monitoring Notification Guidelines

1. Introduction

The South Coast Air Quality Management District (South Coast AQMD) Rule 1180, Refinery and Community Air Monitoring, (http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/r1180.pdf) mandates the implementation of real-time air quality measurements at or near the fenceline of all major refineries in the South Coast Air Basin (Basin). The main objective of this Rule is to provide the public and local response agencies with information about the potential impact of refinery emissions in local communities. Table 1 lists the compounds that are required to be monitored by the refineries under Rule 1180.

Table 1. Air Pollutants to be monitored by the refineries at the fenceline of their facilities under Rule 1180

Criteria Pollutants	Volatile Organic Compounds	Other Compounds
Sulfur Dioxide Nitrogen Oxides	Total VOCs (Non-Methane Hydrocarbons) Formaldehyde Acetaldehyde Acrolein 1,3-Butadiene Styrene BTEX Compounds (Benzene, Toluene, Ethylbenzene, Xylenes)	Hydrogen Sulfide Carbonyl Sulfide Ammonia Black Carbon Hydrogen Cyanide Hydrogen Fluoride

During the rulemaking process South Coast AQMD staff, with input from the community and other major stakeholders, developed a guideline document to assist the refinery owners/operators with the development of the fenceline air monitoring plans for Rule 1180 (http://www.aqmd.gov/docs/default-source/rule-book/support-documents/1180/rule-1180-guidelines.pdf). These guidelines specify that fenceline monitoring systems should "*Provide information about various air pollutant levels (i.e., determined by air pollutant concentration) measured in real-time in durations short enough to adequately address significant emissions changes from refinery operations*", and "*Provide a notification system for communities near refineries when emissions exceed thresholds (e.g., RELs)*".

A number of air quality standards and exposure benchmarks have been established by various regulatory agencies for both criteria and air toxic pollutants. This document provides an overview of these existing standards, and recommended thresholds for Rule 1180 compounds to trigger data notification to the public. Whenever possible, concentrations have been converted to part-per-billion (ppb) for ease of comparison. It is useful to note that for a given pollutant a number of standards exist, which reflect the state of knowledge on available measurement technology at the time of the standard's development. Next generation air quality monitoring

instrumentation (e.g. Optical Remote Sensing; or ORS) offers the capability to monitor air toxics with a time resolution that is higher than that that of more traditional air monitoring techniques (e.g. 5 minute for near real time vs 24 hour for integrated measurements). In addition, some standards are designed for tolerance levels that would cause discomfort or illness, while others are for levels that would be fatal. Overall, air quality standards and exposure benchmarks are defined for one of three levels: levels at which a specific compound would cause discomfort to affected populations; levels at which illness or injury is caused; and levels at which death is likely. It should be noted that in addition to providing important information on potential fugitive emissions from refineries, fenceline measurements are also useful to assess acute (e.g. 1-hr average) exposure in communities directly adjacent to these facilities.

This report is intended to compile and compare these available standards, as well as provide refinery staff with recommendations for the purpose of setting Rule 1180 notification thresholds.

2. Existing Health Based Thresholds

2.1. The Office of Environmental Health Hazard Assessment (OEHHA)

OEHHA is the department within the California Environmental Protection Agency responsible for evaluating health risks related to chemical contaminants. OEHHA exposure thresholds are provided for three time intervals: 1-hour, 8-hour and chronic. The level of the thresholds are based on the available peer reviewed literature on the health effects upon exposure to these pollutants over 1-hr and 8-hr time periods, or for chronic exposure (the latter levels is designed to address continuous exposures for up to a lifetime). All Rule 1180 pollutants, with the exception of Black Carbon (BC), have at least one OEHHA levels established (see Table 2). More detailed information about each gas, including exposure caused health effects, ambient levels and emission sources can be found on the OEHHA website: https://oehha.ca.gov/air/general-info/oehha-acute-8-hour-and-chronic-reference-exposure-level-rel-summary

Table 2. Ambient mixing ratios* of Rule 1180 compounds defined by OEHHA as the threshold for 1-hour, 8-hour and chronic exposure.

Compound	OEHHA Acute 1-hour (ppb)	OEHHA 8-hour (ppb)	OEHHA Chronic (ppb)
Sulfur Dioxide	255.7		
Nitrogen Dioxide	253.5		
1,3 Butadiene	302.8	4.1	0.9
Acrolein	1.1	0.3	0.2
Benzene	8.6	1.0	1.0
Ethylbenzene			467.4
Toluene	9,964.3		80.8
m-Xylene	5,142.3		163.6
n-Hexane			2,015.5

o-Xylene	5,142.3		163.6
Formaldehyde	45.5	7.4	7.4
Acetaldehyde	264.8	169.0	78.9
Styrene	5,000.3		214.4
p-Xylene	5,142.3		163.6
Napthalene			1.7
Hydrogen Sulfide	30.6		7.3
Carbonyl Sulfide	272.6	4.1	4.13
Ammonia	4,662.3		291.4
Hydrogen Fluoride	297.6		17.4
Hydrogen Cyanide	312.2		8.3

**The mixing ratios were converted from µg/m^3 (units used by OEHHA) to ppb using a temperature of 25 °C and 1 bar of atmospheric pressure.*

2.2. California Ambient Air Quality Standards (CAAQS)

CAAQS are set by the California Air Resources Board (CARB) for a specific list of pollutants. Three of the Rule 1180 pollutants have corresponding CAAQS: SO2, NO2, and H2S. For SO2 CAAQS are set for 1-hour and 24-hours averages; for NO2, 1-hour and annual average standards are established; and for H2S, only a 1-hour average CAAQS is set (see Table 3 for details). CAAQS are determined through an extensive process, which includes a scientific literature review and recommendations by OEHHA. This is followed by a public and peer review by their Air Quality Advisory Committee (AQAC), and by another public comment period before approval by the California Air Resources Board hearing. More information on CAAQS can be found here: https://ww2.arb.ca.gov/resources/california-ambient-air-quality-standards

Table 3. California Ambient Air Quality 1-Hour Average Standards for Rule 1180 compounds expressed as ambient mixing ratios (ppb)

Compound	1-hour Average(ppb)	24-hour Average (ppb)	Annual Average (ppb)
Sulfur Dioxide	250	40	N/A
Nitrogen Dioxide	180	N/A	30
Hydrogen Sulfide	30	N/A	N/A

2.3. National Ambient Air Quality Standards (NAAQS)

The NAAQS are set by the US EPA for six specific air pollutants, two of which (SO_2 and NO_2) are listed as Rule 1180 compounds. There are two standards listed for each gas referred to as primary and secondary. The primary level is set to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. The secondary standard is set to protect public welfare, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. More information on NAAQS is available at the following link: https://www.epa.gov/criteria-air-pollutants/naaqs-table

Table 4. National Ambient Air Quality Standards for Rule 1180 compounds expressed as ambient mixing ratios (ppb)

Compound	NAAQS Primary 1-hour (ppb)	NAAQS Secondary (ppb)
Sulfur Dioxide	75	500 (3-hours)
Nitrogen Dioxide	100	53 (Annual Mean)

2.4. Acute Exposure Guideline Levels for Airborne Chemicals (AEGL)

AEGL levels are set by the US EPA and the US Department of Energy (DOE). All Rule 1180 compounds, except for BC, have well established AEGL thresholds. These levels are intended as a reference for first responders in emergency situations (spills, leaks, etc.). As such they are significantly higher than typical ambient air quality thresholds. Compared to the other exposure levels and standards which are typically established for 1- and 8-hour time scales, AEGLs are also defined for shorter time periods (10 min and 30 min). There are three AEGL levels defined:

AEGL-1 is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic, non-sensory effects. However, these effects are not disabling and are transient and reversible upon cessation of exposure.

AEGL-2 is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting, adverse health effects or an impaired ability to escape.

AEGL-3 is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening adverse health effects or death.

More information about AEGLs can be found at the following links:
https://www.epa.gov/aegl/about-acute-exposure-guideline-levels-aegls
https://sp.eota.energy.gov/pac/Search

Table 5. Ambient mixing ratios defined by the US EPA and US DOE as the acute exposure level thresholds. Only South Coast AQMD Rule 1180 compounds have been listed in this Table.

Compound	AEGL-1 1 hour (ppb)	AEGL-1 10 min. (ppb)	AEGL-2 1 hour (ppb)	AEGL-3 1 hour (ppb)
Sulfur Dioxide	200	200	750	30,000
Nitrogen Dioxide	500	500	12,000	20,000
Formaldehyde	900	900	14,000	56,000
Acetaldehyde	45,000	45,000	27, 000	840,000
Acrolein	30	30	100	1,400
1,3-Butadiene	670,000	670,000	5,300,000	22,000,000

Styrene	20,000	20,000	130,000	1,100,000
Benzene	52,000	130,000	800,000	4,000,000
Toluene	67,000	67,000	560,000	3,700,000
Ethylbenzene	33,000	33,000	1,100,000	1,800,000
Hydrogen Sulfide	510	750	27,000	50,000
Carbonyl Sulfide	NR	NR	55,000	150,000
Ammonia	30,000	30,000	160,000	1,100,000
Hydrogen Cyanide	2,000	2,500	7,100	15,000
Hydrogen Fluoride	1,000	1,000	24,000	44,000
m-Xylene	130,000	130,000	920,000	2,500,000
o-Xylene	130,000	130,000	920,000	2,500,000
p-Xylene	130,000	130,000	920,000	2,500,000

2.5. Emergency Response Planning Guidelines (ERPGs)

ERPGs are published by the American Industrial Hygiene Association (AIHA) and represent concentrations for once in a lifetime exposure for up to one hour. There are three levels of expected effects: mild or transient (ERPG-1), irreversible or serious (ERPG-2), and potentially life-threatening (ERPG-3). The current available ERPG values can be found in the following link: https://www.aiha.org/get-involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Documents/2016%20ERPG%20Table.pdf

Table 6. ERPG levels from the American Industrial Hygiene Association. The gases shown here are those recognized by both the AIHA and the South Coast AQMD Rule 1180.

Compound	ERPG-1 (ppb)	ERPG-2 (ppb)	ERPG-3 (ppb)
Sulfur Dioxide	300	3,000	25,000
Nitrogen Dioxide	1,000	15,000	30,000
Formaldehyde	1,000	10,000	40,000
Acetaldehyde	10,000	200,000	1,000,000
Acrolein	50	150	1,500
1,3-Butadiene	10,000	500,000	5,000,000
Styrene	50,000	250,000	1,000,000
Benzene	50,000	150,000	1,000,000
Toluene	50,000	300,000	1,000,000
Hydrogen Sulfide	100	30,000	100,000
Ammonia	25,000	150,000	1,500,000
Hydrogen Cyanide		10,000	25,000
Hydrogen Fluoride	2, 000	20,000	50,000

2.6. Immediately Dangerous to Life and Health (IDLH) levels

These levels are published by the US National Institute for Occupational Safety and Health (NIOSH) and represent concentrations that are "likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment". The most recent values can be found here: https://www.cdc.gov/niosh/idlh/intridl4.html

IDLH levels are included for informational purposes only, but as this level considers levels necessary for immediate life-threatening levels, it is uniformly higher than any other levels described in this document and, thus, was not considered in the final recommendation for the Rule 1180 refinery fenceline notification thresholds.

Table 7. IDLH levels. The gases shown here are those recognized by both NIOSH.

Compound	IDLH Level (ppb)
Sulfur Dioxide	100,000
Nitrogen Dioxide	13,000
Formaldehyde	20,000
Acetaldehyde	2,000,000
Acrolein	2,000
1,3-Butadiene	2,000
Styrene	700,000
Benzene	500,000
Toluene	500,000
Ethylbenzene	800,000
Hydrogen Sulfide	100,000
Ammonia	300,000
Black Carbon	1,750 mg/m^3
Hydrogen Cyanide	50,000
Hydrogen Fluoride	30,000
m-Xylene	900,000
o-Xylene	900,000
p-Xylene	900,000

3. Recommended Notification Thresholds for Fenceline Air Monitoring Under Rule 1180

Table 8 summarizes the air quality exposure levels or standards from the above sources that were considered while developing this guidance document. The averaged observed values throughout the Basin during the Multiple Air Toxics Exposure Study (MATES) IV, as well as data from the West Long Beach MATES IV station, adjacent to the refineries in Carson and Wilmington, are also included for comparison.

In order to provide the community with an acceptable level of protection and the earliest notification, it is recommended to base the notification threshold on the lowest available air quality standard, with the shortest averaging time. This recommendation is based on the desire to use the lowest tolerance limit at the fenceline in order to (a) allow for the early detection of hazardous compounds around refineries; and (b) advise the public of potential harmful pollutants that may be in the downwind direction of refineries. Following this approach, the recommended *1-hour notification thresholds* for each Rule 1180 compound are highlighted in **red** in Table 8. Open path and in-situ air monitoring equipment that will be used by the refineries for fenceline measurements have detection limits that are well above the recommended notification levels (i.e. they can detect ambient concentration levels that are much lower than the threshold levels recommended below). Short term fluctuations in the ambient concentration of most Rule 1180 pollutants at the refinery fenceline are expected, and extreme 5-min concentrations will be immediately reflected in the 1-hr rolling averages.

Table 8. Summary of different air quality standards and exposure benchmarks for Rule 1180 compounds. Recommended thresholds for the fenceline air monitoring systems operated by the refineries as part of Rule 1180 are highlighted in **red**. Observational data from the MATES IV are also included for comparison. Some values have been rounded.

Compound	NAAQS 1-hr (ppb)	CAAQS 1-hour (ppb)	OEHHA Acute 1-hour (ppb)	OEHHA 8-hour (ppb)	OEHHA Chronic (ppb)	AEGL-1 1 hour (ppb)	ERPG-1 (ppb)	MATES IV basin[1] (ppb)	MATES IV W Long Beach[1,*] (ppb)	Resident Cancer Risk 25 in MM[#]	Resident Cancer Risk 100 in MM[#]
Sulfur Dioxide	**75**	250	256			200	300				
Nitrogen Dioxide	**100**	180	254			500	1,000				
Formaldehyde			**45.5**	7.4	7.2	900	1,000	2.23	1.55	1.43	5.73
Acetaldehyde			**265**	169	77	45,000	10,000	0.90	0.75	2.05	8.21
Acrolein			**1.1**	0.3	0.2	30	50				
1,3-Butadiene			**303**	4.1	0.9	670,000	10,000	0.09	0.07	0.03	0.11
Styrene			**5,000**		209	20,000	50,000	0.05	0.07		
Benzene			**8.6**	1.0	0.9	52,000	50,000	0.38	0.36	0.12	0.46
Toluene			**9,964**		79	67,000	50,000	1.06	0.89		
Ethylbenzene					455	33,000		0.21	0.13	0.98	3.91
Hydrogen Sulfide		**30**	**30**		7.1	510	100				
Carbonyl Sulfide			**273**	4.1	4.0						
Ammonia			**4,662**		283	30,000	25,000				
Hydrogen Cyanide			**312**		8.0	2,000					
Hydrogen Fluoride			**298**		16.9	1,000	2,000				
m-Xylene			**5,142**		159	130,000		0.69	0.43		
o-Xylene			**5,142**		159	130,000		0.18	0.12		
p-Xylene			**5,142**		159	130,000		0.69	0.43		

[1]MATES IV concentration data over the Basin, from station data taken from https://www.aqmd.gov/docs/default-source/air-quality/air-toxic-studies/mates-iv/d-appendix.pdf

*MATES IV West Long Beach Station is currently identified as Hudson

[#]Calculated using Risk Assessment Standalone Tool (RAST); https://ww3.arb.ca.gov/toxics/harp/harp.htm

Currently, there is no health based exposure limits for BC. However, the spatial and temporal distribution of BC in the Basin has been studied extensively during MATES IV and, thus, average values at multiple monitoring stations have been included to provide information about their regional variability (Table 9). While the South Coast AQMD does not recommend to set a notification threshold for BC, the refineries should show MATES IV BC concentrations on their live refinery fenceline BC data display. For example, 5%-ile, 95%-ile and average (or median) BC concentrations from the nearest MATES IV station or for the entire Basin should be displayed along with real-time (live) BC data. This will inform the public of how instantaneous BC concentrations at the fenceline compare with the BC levels that have been observed in their community.

Table 9. Ambient BC concentrations observed at selected sites during MATES IV.

	Anaheim (mg/m^3)	Burbank (mg/m^3)	Central Los Angeles (mg/m^3)	Compton (mg/m^3)	Huntington Park (mg/m^3)	North Long Beach* (mg/m^3)	West Long Beach# (mg/m^3)	LA Basin (mg/m^3)
Average	0.92	1.33	1.49	1.14	1.26	0.96	1.45	1.29
5%	0.16	0.23	0.19	0.16	-0.04	0.16	0.21	0.16
25%	0.33	0.54	0.53	0.33	0.28	0.32	0.50	0.43
75%	1.15	1.75	2.03	1.28	1.59	1.14	1.70	1.66
95%	2.99	3.71	4.28	3.98	4.42	3.14	4.71	3.94

*MATES IV North Long Beach Station is currently designated as Long Beach
#MATES IV West Long Beach Station is currently designated as Hudson

Similarly, there are no recommended exposure limits for total non-methane hydrocarbons, and a notification threshold for total Volatile Organic Compounds (VOC's) should not be set. Based on the data recorded by the fenceline air monitoring systems after 6-months of operation, a typical range for total VOC (e.g. 5%-ile, 95%-ile and average) should be established and displayed along with real-time (live) VOC data. Such reference range should be updated quarterly as additional measurements are collected.

Finally, for ethylbenzene, OEHAA does not have an acute 1-hr REL level. Therefore, the recommendation is not to set a notification threshold for this pollutant at the time of commissioning the fenceline air monitoring systems. Fenceline air monitoring data obtained during the first 6 month of operation should be analyzed for correlations between ethylbenzene and other measured pollutants. Based on the results of this analysis, notification threshold may then be established.

Although notifications for refinery fenceline concentration levels will be focusing on short-term exposure and corresponding acute reference exposure limits, an analysis of long-term variations will be required in the refineries' quarterly reports. Specifically, quarterly reports will

have to provide how long-term fenceline averages compare with certain chronic thresholds. Selected examples of these thresholds are presented in Table 8 (e.g. OEHHA Chronic REL, and cancer risk for 25- and 100- in a million (MM))

4. Exceedance Notification Structure

The recommended notification thresholds outlined in Table 8 are based on 1-hr exposure limits. For notification purposes, therefore, it is recommended that for each section of the fenceline, running hourly-averaged fenceline concentrations updated every 5 minutes (individual measurement time) are used. See Section 6 below for guidelines on how to perform such calculation if an individual measurement (i.e. 5-minute averaged open path measurement) is below the instruments' detection limit. An initial notification should be issued at the time when the hourly running average concentration of one or more Rule 1180 pollutants exceeds the recommended threshold for that pollutant (or series of pollutants) at any section of the refinery fenceline. A follow-up notification would be issued when the running averaged fenceline concentrations fall below the threshold. While issuing a notification is recommended when ambient levels of Rule 1180 compounds are above the OEHAA Acute1-hr REL exposure limits (see Section 3), it would be useful to also inform the public if measured concentrations exceed other reference values (e.g. AEGL). Notifications should include at a minimum the following information:

- Name of the pollutant(s) hourly average value at the time of the notification;
- Definition of the threshold;
- Identification of the portion(s) of the fenceline experiencing the exceedance;
- Predominant wind direction at the time of the exceedance;
- Concentration of the corresponding pollutant (if available) at nearest community monitoring station;
- Information on the nearest downwind community;
- Weblink to fenceline data in case of a notification

5. Data reporting

For all Rule 1180 pollutants listed in Table 1, absolute concentrations in ppb, ug/m3, or other appropriate measurement unit at the refinery fenceline (and not fenceline enhancements over atmospheric background) should be reported. Ambient concentrations should be displayed with an appropriate number of significant figures and no less than two decimal points.

Total VOC's, are required for monitoring along the refinery fenceline. Rule 1180 Guidelines describe total VOC's as Non-Methane Hydrocarbons, and CARB defines Non-Methane Hydrocarbons as the sum of all hydrocarbon air pollutants except methane (https://ww2.arb.ca.gov/about/glossary?keywords=&page=8). Various hydrocarbon species absorb strongly around the 3000 cm-1 infrared spectral region. The absorption features of these

hydrocarbons are similar, with the absorption strength scaling to the mass of the alkane species. As a result, Total VOC's can be readily quantified by OP FTIR technology by conducting spectral retrieval in the above mentioned spectral region (the exact retrieval spectral window may vary slightly by vendor and retrieval approach). Similarly to all other Rule 1180 pollutants, absolute concentrations of total VOC's (not enhancements over background) should be reported.

6. Treatment of ambient concentrations below detection limits for open path fenceline air monitors

In the absence of significant refinery emissions/releases it is expected that most Rule 1180 air pollutants would be present at very low concentrations and below their corresponding minimum detection limits (MDL; as detected by open path UV-DOAS and FTIR ORS systems). It is therefore important to follow a consistent procedure to display and interpret fenceline measurements below MDL, and these procedures should be consistent for all refinery fenceline air monitoring systems.

Open path ORS measurements have several advantages over in-situ analytical techniques. Specifically, they allow for simultaneous measurements of multiple Rule 1180 compounds along the entire refinery fenceline, in near real-time, and using a relatively small number of ORS monitors. Pollutants concentrations are obtained by performing a fit of calculated spectra to measured atmospheric spectra collected over approximately 5 minutes time intervals. Although contributing factors to the MDL (e.g., signal-to-noise ratio, the presence of competing absorbers, and other environmental effects) may limit the precision of an individual measurement, this is still significant when averaged over time. The guidance below applies only to valid fenceline measurements below the instrument MDLs (i.e. measurements that passed all quality instrument controls/checks and resulted in a concentration level for a certain pollutant below MDL).

6.1. Real-time 5-min data

For real-time (i.e. 5-minute) data display, pollutant(s) concentrations below the instrument's MDL should not be displayed on the public website. Instead, data display should indicate that the measurement was below the MDL and report this detection limit value. However, all retrieved pollutant concentrations (above and below the MDL) should be archived and analyzed as a part of the refinery's routine QA/QC analysis, and should be available for data download and for QA/QC auditing purposes.

6.2. Time-averaged data

A number of guidelines exist for deriving time-averages for atmospheric datasets containing data points below MDL. Recommendations vary from replacing values below detection limits with the corresponding MDL, ½ of the MDL, using various statistical estimates for values below MDL, and substituting measurements with zero values. For ORS measurements, valid observations (i.e. those that passed all QA/QC checks) contain valuable and statistically relevant information and, hence, they should not be substituted with zero values, as this would artificially bias the time-averaged concentrations low. Similarly, simple substitution of below

MLD values with the MDL would artificially bias the time average levels high, increasing the possibly of unnecessarily alarming the communities. If all values contributing to the rolling hourly average are above the MDL, the rolling one-hour average updated every 5 minutes (time resolution of the ORS measurements) using spectrally retrieved fenceline concentrations should be calculated and reported along with the corresponding MDLs.

If the measurements of a rolling hourly average contain values above and below the MDL the one-hour rolling average is to be calculated based on all values both above and below the MDL. If the resulting hourly average is above the MDL this value should be reported and displayed. If the resulting hourly average is below the MDL, only this level should be reported with a message that the data-point is below the detection limit. All rolling hourly averages below the MDL should be archived as any other valid data points, and made available for data download and QA/QC auditing purposes.

7. Data archive requirements

All Rule 1180 air quality and meteorological data and related quality assurance information should be retained indefinitely and made available for data download on the refinery website. All ORS spectra, wavelength calibration, reference spectra, and other relevant information should also be retained indefinitely, although data sharing on the public website is not necessary (spectral information should be provided to the South Coast AQMD).