BAY AREA
AIR QUALITY
MANAGEMENT
DISTRICT

BOARD OF DIRECTORS
MEETING
JUNE 2, 2021

THIS MEETING WILL BE CONDUCTED UNDER PROCEDURES AUTHORIZED BY EXECUTIVE ORDER N-29-20 ISSUED BY GOVERNOR GAVIN NEWSOM

- **THE PUBLIC MAY OBSERVE THIS MEETING THROUGH THE WEBCAST BY CLICKING THE LINK AVAILABLE ON THE AIR DISTRICT'S AGENDA WEBPAGE AT**

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BOARD OF DIRECTORS MEETING
AGENDA

WEDNESDAY
JUNE 2, 2021
9:30 A.M.

Chairperson, Cindy Chavez

1. **CALL TO ORDER - ROLL CALL**

PLEDGE OF ALLEGIANCE

PUBLIC MEETING PROCEDURE

The Board Chair shall call the meeting to order and the Clerk of the Boards shall take roll of the Board members.

This meeting will be webcast. To see the webcast, please visit www.baaqmd.gov/bodagendas at the time of the meeting. Closed captioning may contain errors and omissions and are not certified for their content or form.

Public Comment on Agenda Items *The public may comment on each item on the agenda as the item is taken up. Members of the public who wish to speak on matters on the agenda for the meeting, will have three minutes each to address the Board. No speaker who has already spoken on that item will be entitled to speak to that item again.*

PUBLIC HEARING

2. Public Hearing to Consider Adoption of Proposed Amendments to Regulation 6: Particulate Matter, Rule 5: Particulate Emissions from Petroleum Refinery Fluidized Catalytic Cracking Units (Rule 6-5) **G. Nudd/4786**
gnudd@baaqmd.gov

A. The Board of Directors will receive an overview on the rule development process for proposed amendments to Regulation 6: Particulate Matter, Rule 5: Particulate Emissions from Petroleum Refinery Fluidized Catalytic Cracking Units (Rule 6-5) and background on the regulatory options considered and discussed at previous Stationary Source and Climate Impacts Committee meetings.

B. The Board of Directors will consider adoption of proposed amendments to Regulation 6: Particulate Matter, Rule 5: Particulate Emissions from Petroleum Refinery Fluidized Catalytic Cracking Units (Rule 6-5).

END OF PUBLIC HEARING

PUBLIC COMMENT ON NON-AGENDA MATTERS

3. **Public Comment on Non-Agenda Items, Pursuant to Government Code Section 54954.3**

   Members of the public who wish to speak on matters not on the agenda for the meeting, will have three minutes each to address the Board.

BOARD MEMBERS' COMMENTS

4. *Any member of the Board, or its staff, on his or her own initiative or in response to questions posed by the public, may: ask a question for clarification, make a brief announcement or report on his or her own activities, provide a reference to staff regarding factual information, request staff to report back at a subsequent meeting concerning any matter or take action to direct staff to place a matter of business on a future agenda. (Gov't Code § 54954.2)*

OTHER BUSINESS

5. Report of the Executive Officer/APCO

6. Chairperson's Report

7. Time and Place of Next Meeting:

   Wednesday, June 16, 2021 at 9:30 a.m., via webcast, pursuant to procedures authorized by Executive Order N-29-20 issued by Governor Gavin Newsom.

8. Adjournment

   The Board meeting shall be adjourned by the Board Chair.

CONTACT:
MANAGER, EXECUTIVE OPERATIONS **(415) 749-4941**
375 BEALE STREET, SAN FRANCISCO, CA 94105 **FAX: (415) 928-8560**
vjohnson@baaqmd.gov **BAAQMD homepage:**
www.baaqmd.gov

- Any writing relating to an open session item on this Agenda that is distributed to all, or a majority of all, members of the body to which this Agenda relates shall be made available at the Air District's offices at 375 Beale Street, Suite 600, San Francisco, CA 94105, at the time such writing is made available to all, or a majority of all, members of that body.

Accessibility and Non-Discrimination Policy

The Bay Area Air Quality Management District (Air District) does not discriminate on the basis of race, national origin, ethnic group identification, ancestry, religion, age, sex, sexual orientation, gender identity, gender expression, color, genetic information, medical condition, or mental or physical disability, or any other attribute or belief protected by law.

It is the Air District's policy to provide fair and equal access to the benefits of a program or activity administered by Air District. The Air District will not tolerate discrimination against any person(s) seeking to participate in, or receive the benefits of, any program or activity offered or conducted by the Air District. Members of the public who believe they or others were unlawfully denied full and equal access to an Air District program or activity may file a discrimination complaint under this policy. This non-discrimination policy also applies to other people or entities affiliated with Air District, including contractors or grantees that the Air District utilizes to provide benefits and services to members of the public.

Auxiliary aids and services including, for example, qualified interpreters and/or listening devices, to individuals who are deaf or hard of hearing, and to other individuals as necessary to ensure effective communication or an equal opportunity to participate fully in the benefits, activities, programs and services will be provided by the Air District in a timely manner and in such a way as to protect the privacy and independence of the individual. Please contact the Non-Discrimination Coordinator identified below at least three days in advance of a meeting so that arrangements can be made accordingly.

If you believe discrimination has occurred with respect to an Air District program or activity, you may contact the Non-Discrimination Coordinator identified below or visit our website at www.baaqmd.gov/accessibility to learn how and where to file a complaint of discrimination.

Questions regarding this Policy should be directed to the Air District's Non-Discrimination Coordinator, Terri Levels, at (415) 749-4667 or by email at tlevels@baaqmd.gov.

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
375 BEALE STREET, SAN FRANCISCO, CA 94105
FOR QUESTIONS PLEASE CALL (415) 749-4941

EXECUTIVE OFFICE:
MONTHLY CALENDAR OF AIR DISTRICT MEETINGS

MAY 2021

TYPE OF MEETING	DAY	DATE	TIME	ROOM
Board of Directors Technology Implementation Office (TIO) Steering Committee	Friday	28	1:00 p.m.	Webcast only pursuant to Executive Order N-29-20

JUNE 2021

TYPE OF MEETING	DAY	DATE	TIME	ROOM
Board of Directors Meeting	Wednesday	2	9:30 a.m.	Webcast only pursuant to Executive Order N-29-20
Board of Directors Community Equity, Health and Justice Committee	Thursday	3	9:30 a.m.	Webcast only pursuant to Executive Order N-29-20
Board of Directors Meeting	Wednesday	16	9:30 a.m.	Webcast only pursuant to Executive Order N-29-20
Board of Directors Legislative Committee	Wednesday	16	1:00 p.m.	Webcast only pursuant to Executive Order N-29-20
Board of Directors Stationary Source and Climate Impacts Committee	Monday	21	9:00 a.m.	Webcast only pursuant to Executive Order N-29-20
Board of Directors Mobile Source and Climate Impacts Committee	Thursday	24	9:30 a.m.	Webcast only pursuant to Executive Order N-29-20

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
Memorandum

To: Chairperson Cindy Chavez and Members of the Board of Directors

From: Jack P. Broadbent
Executive Officer/APCO

Date: May 26, 2021

Re: Public Hearing to Consider Adoption of Proposed Amendments to Regulation 6: Particulate Matter, Rule 5: Particulate Emissions from Petroleum Refinery Fluidized Catalytic Cracking Units (Rule 6-5)

RECOMMENDED ACTION

Recommend the Board of the Directors consider adoption of proposed amendments to Regulation 6, Rule 5: Particulate Emissions from Petroleum Refinery Fluidized Catalytic Cracking Units (Rule 6-5).

BACKGROUND

California Assembly Bill 617 (AB 617) directed local air districts to adopt an expedited schedule for implementation of Best Available Retrofit Control Technology (BARCT) at industrial Cap-and-Trade sources. In December 2018, the Air District Board of Directors adopted the AB 617 Expedited BARCT Implementation Schedule which identified several potential rule development efforts to further reduce emissions of criteria pollutants at these sources. One of the potential rule development efforts was amending Rule 6-5 to further reduce particulate matter (PM) emissions from petroleum refinery fluidized catalytic cracking units (FCCUs).

Air District staff proposes amendments to Rule 6-5 to address emissions of particulate matter, including condensable particulate matter, from petroleum refinery FCCUs. FCCUs are some of the largest individual sources of PM emissions in the San Francisco Bay Area. The Bay Area does not currently attain all state and national ambient air quality standards for PM, therefore further reductions of these emissions are needed to ensure progress towards attainment of state and national ambient air quality standards and to provide cleaner air and public health benefits. PM causes adverse respiratory health effects, and recent evidence also indicates that fine PM is the most significant air pollution health hazard in the Bay Area.

Reducing PM from FCCUs will also yield health benefits to communities living near refineries, which will further the goals of AB 617. Under AB 617, BARCT standards are one of the regulatory tools to use to reduce the impacts of air pollutants such as PM on disadvantaged communities. One of the FCCUs, which is located at the Chevron Products Refinery in Richmond, is near to a disadvantaged community identified through the AB 617 process. Modeling exercises conducted by the Air District suggest that the emissions impact is substantial, and emissions reductions associated with proposed amended Rule 6-5 would benefit the communities surrounding the FCCU.

PART A: RULE DEVELOPMENT PROCESS

Air District staff conducted extensive outreach as part of this rule development effort. Early in the rule development process, staff convened a Refinery Rules Technical Working Group, which consisted of representatives from petroleum refineries that would be subject to the proposed amended rule along with representatives from community advocacy organizations. Staff prepared an Initial Staff Report in May 2020 and requested comments on the associated draft rule amendments. Staff provided updates to the Air District's Stationary Source Committee in June, July, October, and December 2020. Following the release of draft amendments in May 2020, staff further evaluated other more stringent control options for FCCUs. In January 2021, Air District staff released two versions of draft amendments and a workshop report reflecting two alternative control options—a draft limit on total PM_{10} of 0.020 grains per dry standard cubic foot (gr/dscf) or a more stringent total PM_{10} limit of 0.010 gr/dscf. These were referred to as Control Scenario A and Control Scenario B, respectively. Control Scenario A included limits that are achievable through ESP (electrostatic precipitator), feed hydrotreatment, and catalyst additive controls. Control Scenario B includes more stringent limits that are achievable through WGS (wet gas scrubbing) controls. The workshop materials included information about the draft amendments and estimates potential impacts under each control scenario, which are summarized in the tables below.

Draft Amendment Limits

Draft Limit	Control Scenario A	Control Scenario B
Ammonia (NH_3)	10 ppm	10 ppm
Sulfur dioxide (SO_2)	25 ppm (365-day average) 50 ppm (7-day average)	25 ppm (365-day average) 50 ppm (7-day average)
Total PM_{10}	0.020 gr/dscf	0.010 gr/dscf
Effective date	January 1, 2023	January 1, 2026

Preliminary Estimates of Potential Impacts

Impact Type	Control Scenario A	Control Scenario B
Affected Refineries	Chevron Products Richmond PBF Martinez Refinery	Chevron Products Richmond PBF Martinez Refinery Marathon Martinez Refinery*
Anticipated Controls	Improvement/expansion of existing controls: Electrostatic precipitator (ESP), feed hydrotreatment, catalyst additives	Installation of wet gas scrubbing (WGS) system
PM_{10} Emission Reductions	250 tons per year	493 tons per year*
Total Capital Costs	$110 million	$732 million*
Total Annualized Costs	$19 million per year	$116 million per year*
Cost Effectiveness	$75,000 per ton	$236,000 per ton*

Compliance Cost as a Percentage of Individual Facility Est. Profits	1.6% – 8.1%	13.7% – 25.8%*
Socioeconomic Impacts	Not Significant	Significant (Potential for job losses and/or fuel price increases)
Environmental Impacts	Significant air quality impacts during construction	Significant air quality impacts during construction; Significant water use during operation

*Note: These figures include impacts that would be anticipated at the Marathon Martinez Refinery under normal operations of the FCCU. The Marathon Martinez Refinery has been idled since April 2020, and the company has announced there are currently no plans to restart normal refining operations.

In addition, staff presented results from modeling of potential PM exposure reductions and health benefits under the two control scenarios for Chevron Products Richmond and PBF Martinez Refinery. The following table summarizes the analyses for the estimated reductions in annual excess mortality and valuation of health benefits for Control Scenario A and Control Scenario B for each of these refineries.

Estimated Annual Excess Mortality Reduction and Health Benefits Valuation for Chevron Richmond and PBF Martinez

	Control Scenario A	Control Scenario B
Chevron Products Richmond		
Reduction in annual excess mortality	0.7–1.5	1.2–2.7
Estimated annual valuation of health benefits	$6.8–15 million	$12–27 million
PBF Martinez Refinery		
Reduction in annual excess mortality	1.0–2.2	1.4–3.2
Estimated annual valuation of health benefits	$10–23 million	$14–32 million

Staff held a virtual public workshop on February 4, 2021 to receive feedback on Control Scenarios A and B. Staff received many comments during the workshop and many written comments thereafter. Commenters provided feedback on a variety of topics, with several commenters expressing:

- Support for the most stringent requirements and use of wet gas scrubbing systems;
- Importance of reducing health impacts in the Bay Area and fenceline communities;
- Concern for potential job losses and economic impacts;
- Concern for environmental impacts of water use; and
- Support for a balance between environmental benefits and economic impacts.

In response to the comments received, staff developed a third potential approach to amend Rule 6-5, with the goal of speeding implementation of emissions reductions while retaining strict emission limits. This third regulatory concept retained the same stringent limits as Control Scenario B above, but it provided additional flexibility and opportunity for facilities to potentially mitigate negative impacts by extending the compliance timeline for the most stringent limits. This scenario would involve a phase-in period such that facilities would be required to meet an interim emissions standard like that described in Control Scenario A as soon as possible. The limit would then become more stringent to match that in Control Scenario B. The benefits of this third potential approach include the possibility of requiring health-protective emissions reductions sooner, and it would provide facility operators greater flexibility in planning for installation of wet gas scrubbers to meet the most stringent requirements. The challenges of this approach include a possible delay in the implementation of the most stringent control level identified in Control Scenario B, and it could result in a greater overall cost to the facility than only installing a wet gas scrubber.

The Air District staff presented updates on the workshop, materials, and comments received at an Air District Stationary Source and Climate Impacts Committee meeting on March 15, 2021. Staff presented information on Control Scenario A, Control Scenario B, and the third option described in the paragraph above (referred to as the "Stair-Step approach"), along with the following potential paths forward and next steps for amending Rule 6-5 for Committee input:

- Path 1: Prepare Scenario A **and** Scenario B for consideration by the Air District's Board of Directors in June 2021;
- Path 2: Prepare Scenario A or Scenario B for Board consideration in June 2021; or
- Path 3: Develop draft rule language for the Stair-Step approach, present the draft rule language in a public workshop, and prepare for Board consideration in September 2021.

In that meeting, a majority of Committee members expressed a preference to proceed with Path 2: Prepare Scenario B for consideration by the Air District's Board of Directors in June 2021.

PART B: CURRENT PROPOSAL

The proposed amendments to Rule 6-5 include new and modified limits on ammonia, sulfur dioxide, and total particulate matter less than 10 microns in diameter (total PM_{10}), which includes both filterable and condensable particulate matter. The proposed amendments would also include modifications to existing rule language to clarify existing provisions and improve monitoring requirements. The current proposal asks the Board of Directors to consider adopting the more stringent level of control, a total PM_{10} limit of 0.010 gr/dscf.

The proposed amendments would apply to the four FCCUs in the Bay Area at the following refineries: Chevron Products Richmond, PBF Martinez Refinery, Marathon Martinez Refinery, and Valero Benicia Refinery. Staff anticipates that Chevron Products Richmond, PBF Martinez Refinery, and Marathon Martinez Refinery would be required to install wet gas scrubbing systems at their FCCUs to comply with the proposed amendments. The proposed amendments would result in PM emissions reductions of 493 tons per year. An analysis of the potential environmental impacts of the proposed amendments concluded that installation of these wet gas scrubbing systems would result in potentially significant air quality impacts during construction of the control equipment, and potentially significant water demand impacts from the operation of the wet gas scrubbers. The proposed amendments may also result in potentially significant economic impacts due to the estimated cost of the wet gas scrubbing installations.

BUDGET CONSIDERATIONS/FINANCIAL IMPACT

None. Provisions in this rule proposal will have minor impacts on the following divisions within the Air District: Engineering, Compliance and Enforcement, and Meteorology and Measurements. In each case, staff will fit the minor increases in work into existing workload priorities. No increase in personnel or costs is anticipated.

Respectfully submitted,

Jack P. Broadbent
Executive Officer/APCO

Prepared by:	David Joe
Reviewed by:	Elizabeth Yura

Attachment 1:	Board Resolution (Draft) and Proposed Amendments to Regulation 6, Rule 5: Particulate Matter from Refinery Fluid Catalytic Cracking Unit
Attachment 2:	Final Staff Report – Proposed Amendments to Regulation 6, Rule 5: Particulate Emissions from Petroleum Refinery Fluidized Catalytic Cracking Units
Attachment 3:	Response to Comments on Proposed Amendments to Regulation 6, Rule 5: Particulate Emissions from Petroleum Refinery Fluidized Catalytic Cracking Units
Attachment 4:	Transportation Fuels Trends, Jet Fuel Overview, Fuel Market Changes & Potential Refinery Closure Impacts Presentation to the BAAQMD Board of Directors Special Meeting on May 5, 2021
Attachment 5:	Advisory Council Particulate Matter Reduction Strategy Report
Attachment 6:	Resolution No. 2018 - 08

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

RESOLUTION NO. 2021-

A Resolution of the Board of Directors of the Bay Area Air Quality Management District Amending District Regulation 6, Rule 5: Particulate Emissions from Refinery Fluidized Catalytic Cracking Units

WHEREAS, public hearings have been properly noticed in accordance with the provisions of Health & Safety Code § 40725;

WHEREAS, the Board of Directors of the Bay Area Air Quality Management District ("Air District" or "District") has determined that a need exists to amend District rules and regulations by adopting amendments to Regulation 6, Rule 5: Particulate Emissions from Refinery Fluidized Catalytic Cracking Units, as set forth in Attachment A hereto ("Proposed Amendments");

WHEREAS, the Board of Directors of the Air District obtains its authority to adopt, amend or repeal rules and regulations from Sections 40000, 40001, 40702, and 40725 through 40728.5, of the California Health & Safety Code;

WHEREAS, the Board of Directors of the Air District has determined that the Proposed Amendments are written and displayed so that their meaning can be easily understood by the persons directly affected by the rule;

WHEREAS, the Board of Directors of the Air District has determined that the Proposed Amendments are in harmony with and not in conflict with or contradictory to existing statutes, court decisions, and state and federal regulations;

WHEREAS, the Board of Directors of the Air District has determined that the Proposed Amendments do not impose the same requirements as any existing state or federal regulation, and are necessary and proper to execute the power and duties granted to, and imposed upon, the Air District;

WHEREAS, the Board of Directors of the Air District, by adopting the Proposed Amendments, is implementing, interpreting or making specific the provisions of Health & Safety Code § 40001 (rules to achieve ambient air quality standards), and § 40702 (rulemaking actions that are necessary and proper to execute the powers and duties granted to it);

WHEREAS, pursuant to California State Law AB 617, the Air District on December 19, 2018 adopted an Expedited Schedule for Best Available Retrofit Control Technology Implementation Schedule ("Expedited BARCT Schedule") describing and setting a schedule for adoption of certain rules;

WHEREAS, among the rules scheduled for adoption in the Expedited BARCT Schedule was amendments to Regulation 6, Rule 5 intended to reduce particulate matter from Fluidized Catalytic Cracking Units at Bay Area refineries;

WHEREAS, adoption of the Expedited BARCT Schedule was deemed a CEQA "project" and was evaluated in an Environmental Impact Report certified by the Board of Directors on December 19, 2018;

WHEREAS, the Air District prepared initial draft amendments, published them for comment, and held an online workshop on February 4, 2021, to discuss the draft amendments with interested parties and the public;

WHEREAS, Air District staff discussed concepts for possible amendments to Regulation 6, Rule 5 with the Stationary Source Committee of the Board of Directors on June 17, 2020, July 29, 2020, October 1, 2020, December 17, 2020, and March 15, 2021;

WHEREAS, on March 30, 2021, Air District staff revised the draft amendments based on comments received during and after the February 4, 2021 workshop and published the revised draft amendments for comment in advance of the public hearing to consider adoption of amendments to Regulation 6, Rule 5;

WHEREAS, on March 30, 2021, the Air District transmitted the text of the draft amendments to California Air Resources Board;

WHEREAS, on or before March 30, 2021, Air District staff published in newspapers and distributed and published on the District's website notice of a public hearing to be held on June 2, 2021 to consider adoption of the draft amendments, and the notice included a request for public comments and input on the draft amendments;

WHEREAS, the Board of Directors of the Air District held a public hearing on June, 2 2021, to consider the Proposed Amendments in accordance with all provisions of law ("Public Hearing");

WHEREAS, at the Public Hearing, the subject matter of the Proposed Amendments was discussed with interested persons in accordance with all provisions of law;

WHEREAS, Air District staff has prepared and presented to the Board of Directors a detailed Staff Report and a Response to Comments document regarding the Proposed Amendments, which have been considered by this Board and is incorporated herein by reference;

WHEREAS, the Board of Directors finds and determines that the Proposed Amendments are considered a "project" pursuant to the California Environmental Quality Act ("CEQA") (Public Resources Code § 21000 *et seq*.);

WHEREAS, the Air District is the CEQA lead agency for this project pursuant to CEQA Guidelines § 15050 (14 California Code of Regulations ("CCR") § 15050);

WHEREAS, the 2018 BARCT Schedule EIR addressed in detail the impacts of two approaches for controlling particulate matter emissions at Fluidized Catalytic Cracking Units at petroleum oil refineries, including the approach codified in the Proposed Amendments;

WHEREAS, the 2018 BARCT Schedule EIR found that the approach to controlling particulate matter emissions at Fluidized Catalytic Cracking Units in the Proposed Amendments would result in air quality impacts associated with the construction of air pollution control equipment would be potentially significant after mitigation and cumulatively considerable, and that water demand impacts from the operation of air pollution control equipment were found to be potentially significant after mitigation and cumulatively considerable;

WHEREAS, the Board of Directors finds that the 2018 BARCT Schedule EIR continues to be an adequate analysis of impacts as required under CEQA, including the assessment that adoption of the Proposed Amendments will result in significant environmental impacts after mitigation and be cumulatively considerable;

WHEREAS, the Board of Directors, in adopting the 2018 BARCT Schedule EIR, also adopted a Statement of Overriding Considerations explaining why the significant and unavoidable impacts to air quality during construction and from increases in water demand are acceptable because the public health and air quality benefits from the Expedited BARCT Schedule outweigh these significant unavoidable impacts;

WHEREAS, the Board of Directors continues to rely on both the 2018 BARCT Schedule EIR and the December 19, 2018, Statement of Overriding Considerations in support of adoption of the Proposed Amendments;

WHEREAS, the Board of Directors, pursuant to the requirements of Health & Safety Code § 40728.5, has actively considered the socioeconomic impacts of the Proposed Amendments and has reviewed and considered the "Socioeconomic Impact Analysis: Proposed Amendments to Regulation 6, Rule 5: Particulate Emissions from Refinery Fluidized Catalytic Cracking Units," prepared for the Air District by Applied Development Economics of Walnut Creek, California, which concludes that the Proposed Amendments will potentially have a significant economic impact on affected facilities, but that economic impacts could likely be mitigated to less than significant levels;

WHEREAS, the Board of Directors, pursuant to the requirements of Health & Safety Code § 40728.5, has made a good faith effort to minimize adverse socioeconomic impacts of the Proposed Amendments;

WHEREAS, the Board of Directors, pursuant to the requirements of Health & Safety Code § 40920.6, has actively considered the incremental cost-effectiveness of the Proposed Amendments in meeting emission reduction goals under the California Clean Air Act as set forth in the Staff Report, and finds and determines that there are no incrementally more cost-effective potential control options that would achieve the emission reduction objectives of the Proposed Amendments;

WHEREAS, the Air District has prepared, pursuant to the requirements of Health & Safety Code § 40727.2, a written analysis of federal, state, and District requirements applicable to this source category and has found that the Proposed Amendments would not be conflict with any federal, state, or other Air District rules, and the Board of Directors has agreed with these findings;

WHEREAS, the documents and other materials that constitute the record of proceedings on which this rulemaking project is based are located at the Bay Area Air Quality Management District, 375 Beale Street, San Francisco, 94105, and the custodian for these documents is Marcy Hiratza, Clerk of the Boards;

WHEREAS, Air District staff recommends adoption of the Proposed Amendments;

WHEREAS, the Board of Directors concurs with Air District staff's recommendations and desires to adopt the Proposed Amendments;

NOW, THEREFORE, BE IT RESOLVED that the Board of Directors of the Bay Area Air Quality Management District does hereby adopt the Proposed Amendments, pursuant to the authority granted by law, as set forth in Attachment A hereto, and discussed in the Staff Report (including Appendices) with instructions to Air District staff to correct any typographical or formatting errors before final publication of the Proposed Amendments.

The foregoing Resolution was duly and regularly introduced, passed and adopted at a regular meeting of the Board of Directors of the Bay Area Air Quality Management District on the Motion of Director ________________, seconded by Director ________________, on the 2nd day of June, 2021 by the following vote of the Board:

AYES:

NOES:

ABSENT:

____
Cindy Chavez
Chairperson of the Board of Directors

ATTEST:

____
John J. Bauters
Secretary of the Board of Directors

ATTACHMENT A

[PROPOSED AMENDMENTS]

Amended Regulation 6, Rule 5: Particulate Emissions from Petroleum Refinery Fluidized Catalytic Cracking Units

REGULATION 6
PARTICULATE MATTER
RULE 5
PARTICULATE EMISSIONS FROM PETROLEUM REFINERY FLUIDIZED CATALYTIC CRACKING UNITS

INDEX

6-5-300 STANDARDS

6-5-400 ADMINISTRATIVE REQUIREMENTS

6-5-500 MONITORING AND RECORDS

6-5-600 MANUAL OF PROCEDURES

REGULATION 6
PARTICULATE MATTER
RULE 5
PARTICULATE EMISSIONS FROM PETROLEUM REFINERY FLUIDIZED CATALYTIC CRACKING UNITS

(Adopted December 16, 2015)

6-5-100 GENERAL

6-5-101 Description: This rule limits the emissions of particulate matter, including filterable and condensable particulate matter~~ emissions~~ from petroleum refinery fluidized catalytic cracking units (FCCUs) as well as emissions of precursors of secondary particulate matter. Regulation 6, Rule 1 addresses filterable particulate emissions from FCCUs. For the purposes of this rule, commingled ~~ammonia, condensable particulate and sulfur dioxide~~ emissions from an FCCU and one or more other sources from a single exhaust point shall all be considered to be FCCU emissions as described in District Regulation 1, Section 107.

6-5-110 EXEMPTIONS

6-5-111 Limited Exemption, Emissions Abated by Wet Scrubber: The emission limit for ammonia in Section 6-5-301.1 ~~requirements of this rule~~ shall not apply to sources that are abated by a wet scrubber that is required to be operated by a District permit and that constitutes best available control technology (BACT) for any pollutant when permitted or constructed.

Amended December 19, 2018

6-5-112 Limited Exemption, Emissions during Startup or Shutdown Periods: The emission limit for ammonia in Section 6-5-301.1 and short-term seven-day rolling average emission limit for sulfur dioxide in ~~requirements of~~ Section 6-5-301.2.2 shall not apply to emissions during an FCCU startup or shutdown period. FCCU startup and shutdown periods shall be as defined in this rule, unless a different period is specified in a District Permit to Operate for an FCCU, in which case the Permit to Operate shall take precedence. This exemption is also applicable to a non-FCCU source with startup or shutdown provisions specified in a Permit to Operate, if that source is subject to the requirements of Section 6-5-301 because the source emissions are commingled with those of an FCCU at a single exhaust point; the startup or shutdown provisions specified in the Permit to Operate shall be the basis for this exemption. Whenever this exemption applies to any source, it shall apply to all sources with commingled emissions.

6-5-113 Deleted [date of adoption]~~**Limited Exemption, Installation of Wet Scrubber:** The emission limit effective date for ammonia in Section 6-5-301 may be extended to a later date specified in a District Authority to Construct for an existing FCCU to be controlled with a new wet scrubber, but may not be extended by more than 36 months.~~

6-5-114 Limited Exemption, FCCU without Nitrogen-Based Additives: The emission limit for ammonia in Section 6-5-301.1 shall not apply to an FCCU where ammonia, urea or any other nitrogen-based additive is not used in a way that contributes to ammonia or condensable particulate FCCU emissions.

6-5-115 Limited Exemption, Ammonia Optimization:

115.1 Before [5 years after date of adoption], ~~T~~the ammonia emission limit in Section 6-5-301.1 shall not apply to the owner/operator of a petroleum refinery that implements an optimization of ammonia and/or urea injection in accordance with Section 6-5-403.

115.2 Effective [5 years after date of adoption], the ammonia emission limit in Section 6-5-301.1 shall apply to all owner/operators previously exempt under Section 6-5-115.1.

6-5-200 DEFINITIONS

6-5-201 Ammonia Slip: Ammonia slip is the amount of unreacted ammonia emitted to the atmosphere from the FCCU, regardless of the source of the ammonia.

6-5-202 Catalyst Regeneration Unit (CRU): A catalyst regeneration unit regenerates spent FCCU catalyst by burning off the coke that has deposited on the catalyst surface. The resulting CRU flue gas is the primary emission source addressed by this rule.

6-5-203 Condensable Particulate Matter: Liquid droplets that coalesce, or gaseous emissions that condense to form liquid or solid particles. These liquid and/or solid particles are identified as condensable organic or condensable inorganic particulate matter using EPA Test Method 202.

6-5-204 Daily Average: The arithmetic mean of the measured ammonia emissions subject to Section 6-5-301.1 on any calendar day that the FCCU operates.

6-5-205 FCCU Shutdown: Unless otherwise specified in a District Permit to Operate, FCCU shutdown is a period which begins when fresh feed flow to the FCCU reactor stops and ends when the main blower for catalyst recirculation is shutdown.

6-5-206 FCCU Startup: Unless otherwise specified in a District Permit to Operate, FCCU startup is a period not exceeding 120 hours which begins with the startup of the main blower for introduction of catalyst and ends after fresh feed is introduced to the FCCU reactor, when the process reaches steady state.

6-5-207 Fluidized Catalytic Cracking Unit (FCCU): A fluidized catalytic cracking unit (FCCU) is a processing unit that converts heavy petroleum fractions, typically from crude oil distillation units, into lighter fuel intermediates by using a fine, powdered catalyst to promote a chemical reaction in which the heavy petroleum molecules are broken into smaller molecules. In addition to the cracking reactor, an FCCU includes a catalyst regeneration unit (CRU), ancillary equipment including blowers, and all equipment for controlling air pollutant emissions and recovering heat.

6-5-208 Petroleum Refinery: An establishment that is located on one or more contiguous or adjacent properties that processes crude oil to produce more usable products such as gasoline, diesel fuel, aviation fuel, lubricating oils, asphalt or petrochemical feedstocks. petroleum refinery processes include separation processes (e.g., atmospheric or vacuum distillation, and light ends recovery), petroleum conversion processes (e.g., cracking, reforming, alkylation, polymerization, isomerization, coking, and visbreaking) petroleum treating processes (e.g., hydrodesulfurization, hydrotreating, chemical sweetening, acid gas removal, and deasphalting), feedstock and product handling (e.g., storage, blending, loading, and unloading), auxiliary facilities (e.g., boilers, waste water treatment, hydrogen production, sulfur recovery plant, cooling towers, blowdown systems, compressor engines, and power plants).

6-5-209 **Primary Particulate Matter:** Material emitted to the atmosphere as filterable or condensable particulate matter.

6-5-210 **Secondary Particulate Matter:** Material emitted to the atmosphere in a gaseous form that will not coalesce or condense to a solid or liquid form at atmospheric temperature and pressure, but that may react in the atmosphere into a solid or liquid form. For the purposes of this rule, precursors of Secondary Particulate Matter shall include sulfur dioxide (SO_2) and ammonia.

6-5-211 **Wet Scrubber:** A device that removes air pollutants from gas streams by contacting the gas stream with a scrubbing liquid.

6-5-212 **Total Particulate Matter 10 Microns or Less in Diameter (Total PM_{10}):** Material emitted to the atmosphere as filterable particulate matter or condensable particulate matter less than 10 microns in diameter.

6-5-213 **Total Particulate Matter 2.5 Microns or Less in Diameter (Total $PM_{2.5}$):** Material emitted to the atmosphere as filterable particulate matter or condensable particulate matter less than 2.5 microns in diameter.

6-5-300 STANDARDS

6-5-301 **Fluidized Catalytic Cracking Unit (FCCU) Emission Limits:** The owner/operator of a petroleum refinery that includes an FCCU shall not cause emissions to the atmosphere from the FCCU that exceed the limits in Table 1 on or after the indicated effectiveness date:

Table 1 – FCCU Emission Limits

Section	**Pollutant**	**Emission Limit**		**Effective Date**
301.1	Ammonia	10 ppmvd at 3% O_2 as a daily average		January 1, 2018 or [5 years after date of adoption] for an owner/operator previously exempt under Section 6-5-115.1
301.2	Sulfur Dioxide	2.1	25 ppmvd at 0% O_2 on a 365-day rolling average basis; and	[5 years after date of adoption]
		2.2	50 ppmvd at 0% O_2 on a 7-day rolling average basis	[5 years after date of adoption]

301.3	Total PM_{10}	0.010 gr/dscf at 5% O_2 on a rolling four-quarter average basis	[5 years after date of adoption]

Amended December 19, 2018

6-5-400 ADMINISTRATIVE REQUIREMENTS

6-5-401 Ammonia Control Plan and Permit Applications: No later than January 1, 2017, the owner/operator of a petroleum refinery subject to the ammonia emission limit in Section 6-5-301.1 shall submit to the APCO a control plan detailing the measures, if any, to be taken in order to meet the requirements of Section 6-5-301.1, and also applications for all Authorities to Construct necessary for compliance with Section 6-5-301.1.

6-5-402 Ammonia Monitoring Plan: No later than January 1, 2017, the owner/operator of a petroleum refinery that includes an FCCU subject to the ammonia emission limit in Section 6-5-301 shall submit to the APCO a plan for the installation of an ammonia monitoring system to perform monitoring as required by Section 6-5-501. This plan shall identify the proposed monitoring technique, monitoring equipment, installation details and installation schedule.

6-5-403 Ammonia Optimization: Effective until [5 years after date of adoption], a~~A~~s an alternative to compliance with the ammonia emission limit of Section 6-5-301 per the limited exemption in Section 6-5-115.1, the owner/operator of a petroleum refinery may instead establish an enforceable ammonia emission limit for the FCCU that results in the minimization of total FCCU $PM_{2.5}$ emissions (including all condensable particulate matter), as follows:

403.1 No later than March 1, 2016, the petroleum refinery owner/operator shall submit to the APCO an Optimization and Demonstration Protocol for the purpose of establishing the minimum rate of ammonia and/or urea injection necessary to minimize total $PM_{2.5}$ FCCU emissions (including all condensable particulate matter) while complying with all existing permit requirements, excluding permit requirements that are not based on District BACT requirements, on District prohibitory rule limits or on federal consent decrees. The Optimization Protocol shall include the ammonia and/or urea injection rates to be evaluated and the criteria for selecting these rates, and also the criteria for determining the Optimized Ammonia Emissions Concentration that minimizes total FCCU $PM_{2.5}$ emissions.

403.2 Within 60 days, the APCO shall either approve or disapprove the Optimization and Demonstration Protocol.

403.3 The petroleum refinery owner/operator shall commence and complete the Optimization and Demonstration Protocol, approved by the APCO, no later than June 30, 2017.

403.4 The petroleum refinery owner/operator shall report to the APCO the results of the Optimization and Demonstration Protocol and the proposed Optimized Ammonia Emissions Concentration no later than August 31, 2017. No later than this same date, the petroleum refinery owner/operator shall submit a District permit application to 1) establish the Optimized Ammonia Emissions Concentration as an enforceable permit requirement, and to 2) relax any existing permit conditions that are not based on District BACT requirements, on District prohibitory rule limits or on federal consent decrees to the extent necessary to minimize total FCCU $PM_{2.5}$ emissions.

403.5 Disapproval of an Optimization and Demonstration Protocol, or a failure to meet any requirement or deadline in this section shall not constitute a violation of this rule, but shall preclude the applicability of the limited exemption in Section 6-5-115.1.

6-5-404 Reporting Requirements: The owner/operator of a petroleum refinery that includes an FCCU subject to the requirements in Section 6-5-301 shall submit a written report for each calendar month to the APCO. The report shall be due by the 30th day following the end of the calendar month. The report shall be submitted electronically in an APCO approved format and shall include a summary of the data obtained from the monitoring systems required or source testing conducted pursuant to Sections 6-5-501 and 6-5-503.

6-5-500 MONITORING AND RECORDS

6-5-501 Ammonia Monitoring: The owner/operator of a petroleum refinery that includes an FCCU subject to the ammonia emission limit in Section 6-5-301.1 shall, no later than January 1, 2018, operate one of the following:

501.1 A mass-balance monitoring system that includes all of the following:

1.1 Parametric monitors that comply with District Regulation 1, Section 523 to continuously measure the injection or addition rate (pounds per hour) of ammonia, urea or any other nitrogen-based additive into the emission stream, and;

1.2 Continuous emission monitors that comply with District Regulation 1, Section 522 to continuously measure NOx and oxygen concentrations at appropriate locations to allow a calculation of the amount of ammonia and/or urea consumed in NOx-reduction reactions, and therefore the remaining, emitted amount of non-consumed ammonia.

501.2 Any other ammonia emission monitoring system approved in writing by the APCO.

6-5-502 Sulfur Dioxide Monitoring: No later than [5 years after the date of adoption], the owner/operator of a petroleum refinery that includes an FCCU subject to the sulfur dioxide limits in Section 6-5-301.2 shall comply with the monitoring requirements of District Regulation 1: General Provisions and Definitions, Sections 1-520 and 522.

6-5-503 Total PM_{10} and Total $PM_{2.5}$ Monitoring: No later than [5 years after the date of adoption], the owner/operator of a petroleum refinery that includes an FCCU subject to the Total PM_{10} emission limit in Section 6-5-301.3 shall implement one of the following:

503.1 A source testing protocol that includes, at a minimum, one source test each calendar quarter for Total PM_{10} and Total $PM_{2.5}$ emissions in accordance with the test methods listed in Sections 6-5-604 and 605. During each source test, the owner/operator shall monitor and record, at a minimum, all operating data for the selected operating parameters of the FCCU control equipment, fresh feed rate, and flue gas flow rate.

503.2 Any other Total PM_{10} and Total $PM_{2.5}$ emission monitoring system approved in writing by the APCO.

6-5-~~502~~504 ~~Ammonia~~ Records: The owner/operator of a petroleum refinery subject to the ~~ammonia emission limit~~ requirements in Section 6-5-301 shall maintain records of the data required to be measured in Sections 6-5-501, 502, and 503. These records shall be kept for a period of at least five years and shall be made available to the APCO on request.

6-5-600 MANUAL OF PROCEDURES

6-5-601 Compliance Determination: All compliance determinations shall be made in the as-found operating condition. Source tests shall meet the requirements set forth in District Manual of Procedures, Volume IV, Source Test Policy and Procedures. No compliance determinations shall be made for the emission limit for ammonia in Section 6-5-301.1 and short-term seven-day rolling average emission limit for sulfur dioxide in Section 6-5-301.2.2 during periods subject to the exemption in Section 6-5-112.

6-5-602 Determination of Ammonia and Oxygen: Determination of ammonia shall be by Regulation 1, Section 522 NOx monitors or other APCO approved ammonia monitoring systems that have been installed pursuant to Section 6-5-501 and that meet the applicable requirements for ammonia monitoring set forth in the District Manual of Procedures. Determination of oxygen shall be by Regulation 1, Section 522 oxygen monitor. Compliance with the ammonia limits in Section 6-5-301.1 shall be determined by the monitoring systems that have been installed pursuant to Section 6-5-501.

6-5-603 Determination of Sulfur Dioxide: Compliance with the sulfur dioxide limits in Section 6-5-301.2 shall be determined by a monitoring system that meets the requirements of District Regulation 1, Section 522.

6-5-604 Determination of Total Particulate Matter 10 Microns or Less in Diameter (Total PM_{10}): Determination of Total PM_{10} shall be by the summation of filterable PM_{10} as measured by EPA Test Method 201A and condensable PM as measured by EPA Test Method 202. Compliance with the Total PM_{10} limit in Section 6-5-301.3 shall be determined by the time-weighted average of all source tests conducted in accordance with the District Manual of Procedures during the previous four calendar quarters.

6-5-605 Determination of Total Particulate Matter 2.5 Microns or Less in Diameter (Total $PM_{2.5}$): Determination of Total $PM_{2.5}$ shall be by the summation of filterable $PM_{2.5}$ as measured by EPA Test Method 201A and condensable PM as measured by EPA Test Method 202.

BAY AREA
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FINAL STAFF REPORT

Proposed Amendments to Regulation 6, Rule 5: Particulate Emissions from Petroleum Refinery Fluidized Catalytic Cracking Units

May 2021

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I. EXECUTIVE SUMMARY

The Bay Area Air Quality Management District (Air District) is proposing amendments to Regulation 6: Particulate Matter, Rule 5: Particulate Emissions from Petroleum Refinery Fluidized Catalytic Cracking Units (Rule 6-5). This Staff Report has been developed to provide information supporting the proposed amendments to Rule 6-5 and is intended to provide the public with information in advance of a Public Hearing on the proposed amendments in June 2021.

Fluidized catalytic cracking units (FCCUs) are the largest single source of particulate matter (PM) emissions at petroleum refineries and are some of the largest individual sources of PM in the San Francisco Bay Area. Scientific understanding of particulate matter emissions has advanced considerably in recent years. Particulate matter emissions can be divided into two categories. One category consists of "filterable" particulates that can be measured at the exit point of the emissions "stack." The other category consists of "condensable" emissions that convert to particle form only after exiting and cooling in the atmosphere. The phrase "total particulate matter" or "total PM" is commonly used to describe the sum of both filterable and condensable portions. Historically, regulation of particulate matter from FCCUs was based on measurement methods that only detected the filterable portion. It is now understood that the amount of condensable particulate matter that forms upon contact with the atmosphere is significant and needs to be considered in determining how to control emissions from FCCUs.

In 2010, the United States Environmental Protection Agency updated test methods for measuring total particulate matter emissions from sources such as FCCUs. The updated methods have been instrumental in understanding that total particulate matter is a more significant problem than it was previously believed to be when only filterable particulate was measured. The first step taken by the Air District to address this new understanding of total particulate matter was the adoption of Rule 6-5 in 2015, which focused on minimizing particulate matter associated with ammonia injection. In adopting Rule 6-5, the Air District stated that further measures to control particulate matter from FCCUs were being considered. The Air District's 2017 Clean Air Plan (a document periodically issued to forecast future regulations) included as "Control Measure SS1" a stated intention to evaluate further controls from FCCUs.

Apart from required planning to achieve ambient air quality standards, the proposed amendments are also part of the Air District's efforts to meet the requirements of California Assembly Bill 617 (2017) which requires the Air District to implement an expedited schedule for implementing best available retrofit technology (BARCT) at industrial facilities covered by the State's Cap-and-Trade program. The Expedited BARCT Implementation Schedule adopted by the Air District in 2018 identified PM emission reductions at FCCUs as a key area where BARCT controls could have a significant impact.

By addressing PM emissions from FCCUs, the proposed amendments to Rule 6-5 follows through on these commitments under the Clean Air Plan and AB 617. The proposed amendments are "necessary" within the meaning of the California Health & Safety Code because they would help attain and maintain ambient air quality standards. The Bay Area does not currently attain all state and national ambient air quality standards for particulate matter, and further reductions of particulate matter emissions are needed for attainment and maintenance of the standards. The District-wide health benefits of attaining and maintaining compliance with the PM ambient air standards are significant. PM causes adverse respiratory health effects, and recent studies have linked PM exposure to a wide range of cardiovascular diseases, impacts to cognitive function, and cancer.[1] Compelling evidence also indicates that fine particulate matter is the most significant air pollution health hazard in the Bay Area, and reductions in particulate matter emissions are needed to achieve further clean air and public health benefits.[2]

As explained in this Report, reducing particulate matter from FCCUs will also yield health benefits to communities living near refineries. In doing so, it will further the goals of AB 617. California Health & Safety Code Section 44391.2, enacted as a part of AB 617, indicates that BARCT standards are one of the regulatory tools to be used to reduce the impact of “criteria pollutants” (of which PM is one) on disadvantaged communities. The FCCU at the Chevron Richmond Refinery is proximate to a “disadvantaged community” identified through the AB 617 process. Modeling exercises conducted by the Air District and described later in this Report suggest that the emissions impact is substantial. AB 617 created a process for development of community-based emission reductions programs. Although these amendments to Rule 6-5 have not been developed as part of a community emissions reduction program as envisioned by AB 617, the amendments would be a significant step in promoting the goals of that program.

Air District staff released draft amendments to Rule 6-5 and an Initial Staff Report in May 2020 for public review and comment and presented information on the draft amendments and rule development effort at Air District Stationary Source Committee meetings throughout 2020. Following the release of the draft amendments in May 2020, staff further evaluated other more stringent control options for these sources. In January 2021, Air District staff released two versions of draft amendments and a workshop report reflecting two alternative control options. Staff received public comments on the materials and conducted a virtual public workshop in February 2021. Air District staff presented updates on the workshop and materials at an Air District Stationary Source and Climate Impacts Committee meeting in March 2021. In that meeting a majority of Committee members expressed a preference to proceed with development of the more stringent of the two control options issued for comment in January. This Staff Report proposes the Board of Directors consider the more stringent level of control. The Report also includes discussion of the less stringent control option. Air District staff believes discussion of both control options will promote a more informed decision by the Board of Directors and a better understanding by the public.

The proposed amendments to Rule 6-5 include new and modified limits on ammonia and sulfur dioxide. The proposed amendments also include a direct limit on total particulate matter less than 10 microns in diameter (total PM_{10}), which includes both filterable and condensable particulate matter. The proposed amendments would also include modifications to existing rule language to clarify existing provisions and improve monitoring requirements.

The proposed amendments would apply to the four FCCUs in the San Francisco Bay Area at the following refineries: Chevron Products Richmond, PBF Martinez Refinery, Marathon Martinez Refinery, and Valero Benicia Refinery. Staff anticipates that Chevron Products Richmond, PBF Martinez Refinery, and Marathon Martinez Refinery would be required to install wet gas scrubbing systems at their FCCUs to comply with the proposed amendments. The proposed amendments would result in particulate matter emissions reductions of 493 tons per year.[3] An analysis of the

[1] BAAQMD, 2012. Understanding Particulate Matter: Protecting Public Health in the San Francisco Bay Area. November.

[2] BAAQMD, 2017. Final 2017 Clean Air Plan: Spare the Air – Cool the Climate. April.

[3] This emission reduction estimate includes potential reductions at the Marathon Martinez Refinery, which was idled in April 2020 and remains indefinitely idled. Further details on the emission reductions by facility can be found in Section IV.

potential environmental impacts of the proposed amendments concluded that installation of these wet gas scrubbing systems would result in potentially significant air quality impacts during construction of the control equipment, and potentially significant water demand impacts from the operation of the wet gas scrubbers. The proposed amendments may also result in potentially significant socioeconomic impacts due to the estimated cost of the wet gas scrubbing installations.

Air District staff released the Staff Report and proposed amendments to Rule 6-5 for public review and comment. Staff accepted written comments and developed responses to comments for inclusion in the final proposal to the Air District Board of Directors for their consideration at a Public Hearing. At the Public Hearing, the Air District Board of Directors will consider the final proposal and receive public input before taking action. Air District staff recommends the Board of Directors adopt the proposed amendments to Regulation 6, Rule 5.

II. BACKGROUND

A. Industry and Source Description

1. Industry Description

Petroleum refineries process crude oil into a variety of products, such as gasoline, aviation fuel, diesel and other fuel oils, lubricating oils, and feedstocks for the petrochemical industry. The processing of crude oil occurs in various process units or plants throughout these facilities, including FCCUs. Four of the five refineries in the San Francisco Bay Area have fluidized catalytic cracking units: Chevron Products Richmond, PBF Martinez Refinery, Marathon Martinez Refinery, and Valero Benicia Refinery. Note that the Marathon Martinez Refinery announced the temporary idling of their refinery, including the facility's FCCU, in April 2020. In July 2020, Marathon announced that the refinery will remain idled indefinitely with no plans to restart normal operations.

2. Fluidized Catalytic Cracking Units

Fluidized catalytic cracking units are complex processing units at refineries that convert heavy components of crude oil into lighter distillates, including gasoline and other high-octane products. Fluidized catalytic cracking units use a fine powdered catalyst that behaves as a fluid when aerated with a vapor. The fluidized catalyst is circulated continuously between a reaction vessel where the catalyst is used to promote the hydrocarbon cracking process and a regenerator where carbonaceous material deposited on the catalyst is burned off. An illustrative diagram of the fluidized catalytic cracking unit is shown in Figure 1.

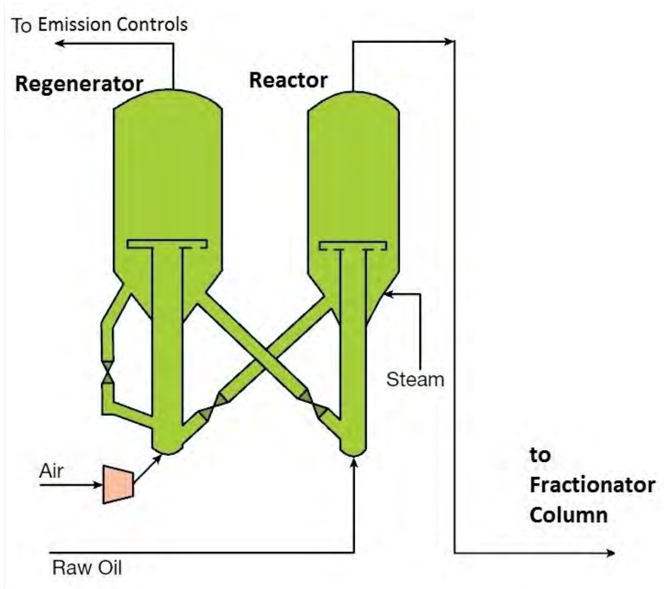

Figure 1 – Petroleum Refinery Fluidized Catalytic Cracking Unit Diagram[4]

Fresh feed is preheated and enters the fluidized catalytic cracking unit at the base of the feed riser, where it is mixed with the heated catalyst. The heat from the catalyst vaporizes the feed and brings the materials up to the desired reaction temperature. The cracking reactions start as the catalyst and hydrocarbon vapor travel up the riser and continue as the materials flow into the reactor. As the cracking reaction progresses, the catalyst surface is gradually coated with carbonaceous material (coke), reducing its efficacy. The cracked hydrocarbon vapors are separated from the catalyst particles by cyclones in the reactor, and the hydrocarbon vapors are sent to a distillation column for separation and further processing.

The spent catalyst is steam stripped to remove remaining oil on the catalyst and cycled to the regenerator. The coke deposited on the catalyst is burned off in a controlled combustion process with preheated air, reactivating the spent catalyst. The catalyst is then recycled to be mixed with fresh hydrocarbon feed. Catalyst regenerators may be designed to burn the coke completely to carbon dioxide (CO_2) (full burn) or to only partially burn the coke to a mixture of carbon monoxide (CO) and carbon dioxide (partial burn). Because the flue gas from partial burn regenerators have high levels of carbon monoxide, the flue gas is vented to a carbon monoxide gas boiler where the carbon monoxide is further combusted to form carbon dioxide.

3. Pollutants and Emission Sources

The fluidized catalytic cracking unit regenerator is a substantial source of emissions and fluidized catalytic cracking units are the largest single source of particulate matter emissions at petroleum refineries. During the regeneration process, some of the catalyst becomes entrained in the flue gas that exits the fluidized catalytic cracking unit regenerator. In addition to these “catalyst fines”, the flue gas also contains other pollutants, including sulfur dioxide (SO_2), oxides of nitrogen (NOx), reactive organic gases (ROG), toxic air contaminants, and other particulate matter (PM) generated in the combustion process. This flue gas is then routed through a train of pollutant abatement devices (see Section II.C. for further information on control technologies). In many

[4] Modified from American Institute of Chemical Engineers, 2014. Chemical Engineering Progress (CEP) – An Oil Refinery Walk-Through. May.

abatement trains, ammonia (NH_3) is also injected into the flue gas stream to enhance the efficiency of certain types of pollution control equipment. Ammonia that is not fully consumed in the process can also remain in the flue gas stream (also referred to as "ammonia slip") and may be emitted along with other pollutants in the flue gas. These gaseous pollutants can increase total particulate matter emissions.

a) Particulate Matter

Particulate matter (PM) is a diverse mixture of suspended particles and liquid droplets, also known as aerosols. Particulate matter varies in terms of size, physical state, chemical composition, and toxicity. Particulate matter emissions can originate from anthropogenic stationary and mobile sources, as well as from natural sources. Particulate matter may consist of elements such as carbon and metals; compounds such as nitrates, organics, and sulfates; and complex mixtures such as diesel exhaust, wood smoke, and soil. Unlike other criteria pollutants which are individual chemical compounds, particulate matter includes all particles that can be suspended in the air.

Particulate matter is often characterized and differentiated based on particle size using the following categories:

- **Total Suspended Particulate (TSP)**: Any airborne particulate matter.
- **PM_{10}**: Particulate matter with an aerodynamic diameter equal to 10 microns or less.
- **$PM_{2.5}$**: Particulate matter with an aerodynamic diameter equal to 2.5 microns or less.
- **Ultrafine Particulate Matter**: Particles smaller than 0.1 micron in diameter.

In addition to size ranges, particulate matter is also classified based on how the particles are formed and emitted. Particulate matter can be categorized as "primary" or "secondary" particulate matter. Primary particulate matter refers to particles that are directly emitted in solid or aerosol form, whereas secondary particulate matter refers to particles that are formed in the atmosphere through chemical reactions.

Primary particulate matter includes soot and liquid aerosols from a wide variety of sources, including cars, trucks, buses, industrial facilities, power plants, cooking, and burning wood, as well as dust from construction sites and other ground disturbing operations. Primary particulate matter can be further classified as filterable particulate matter or condensable particulate matter. Filterable particulate matter describes material that is a liquid or solid at the emission point and is released to the atmosphere. Condensable particulate matter describes material that is a gas at the emission point, but immediately condenses to a liquid or solid form when it exits the stack and is exposed to cooler ambient air. This material exists as a gas at the high temperatures that are typically found at stack conditions. As the hot gases leave the stack and are exposed to ambient air, the gas stream is cooled and diluted, and the gaseous compounds are transformed to a liquid or solid state through condensation, nucleation,[5] and coagulation processes. The formation of condensable particulate matter can vary based on specific characteristics of the gas stream, such as chemical composition, water vapor concentration, and temperature. Gaseous components such as nitrogen oxides, sulfur oxides, ammonia, and organic compounds can contribute to the formation of condensable particulate matter compounds, including sulfates, nitrates, and organic particles.

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[5] Nucleation is the initial process that occurs in the formation of a crystal from a solution, a liquid, or a vapor, in which a small number of ions, atoms, or molecules become arranged in a pattern characteristic of a crystalline solid, forming a site upon which additional particles are deposited as the crystal grows.

Secondary particulate matter may be formed in the atmosphere by gaseous precursors undergoing chemical reactions and physical transformations. In contrast to primary condensable particulate matter, secondary particulate matter can often require minutes, hours, or days to form in the atmosphere. Secondary particulate matter can consist of organic and inorganic compounds that are formed through physical transformations and chemical reactions between precursor gases, including nitrogen oxides, sulfur oxides, ammonia, and organic compounds, that are emitted from various sources.

Even though primary and secondary particulate matter are defined in terms of the processes and sources that produce particulate matter, most individual particles in the atmosphere are in fact a combination of both primary and secondary particulate matter. An individual particle typically begins as a core or nucleus of solid or liquid material, such as carbonaceous material originating from fossil fuels or biomass combustion or geologic dust. Layers of organic and inorganic compounds then condense or deposit onto the particle, causing it to grow in size. These layers are largely comprised of secondary material that is not emitted directly.

b) Health Impacts of Particulate Matter

Since exposure to ambient particulate matter has long been understood as a health hazard,[6] particulate matter was designated as one of the criteria pollutants in the original 1970 federal Clean Air Act. Concerns about particulate matter were initially based on its respiratory health effects, such as aggravating asthma, bronchitis, and emphysema. However, in recent years, many epidemiological studies have linked particulate matter exposure to a much wider range of negative health effects, including cardiovascular effects such as atherosclerosis (hardening of the arteries), ischemic strokes (caused by obstruction of the blood supply to the brain), and heart attacks. Studies also indicate that exposure to particulate matter may be related to other health effects, including reduction in cognitive function, autism, and increased risk of diabetes. Infants and children, the elderly, and persons with heart and lung disease are most sensitive to the effects of particulate matter. Fetal $PM_{2.5}$ exposures can result in low birth weight, pre-term birth, and changes in gene expression, and brain inflammation from particulate matter exposure can affect both ends of the life spectrum—neurodevelopment and neurodegeneration.[7]

Analysis by Air District staff found that $PM_{2.5}$ is the most significant air pollution health hazard in the Bay Area, particularly in terms of premature mortality.[8] A large and growing body of scientific evidence indicates that both short-term and long-term exposure to fine particles can cause a wide range of health effects, and studies have concluded that reducing particulate matter emissions can reduce mortality and increase average life span.[9] Smaller particles can more easily enter the body than their larger counterparts and penetrate deep into the lungs, and from there into the bloodstream. Small particles, such as $PM_{2.5}$, also have much higher surface area relative to mass than larger particles, enabling them to act as carriers for other potentially harmful substances such as trace metals and organic compounds that collect on their surface. There remains no known threshold for harmful $PM_{2.5}$ health effects.[10] Although the epidemiological evidence that shows strong correlation between elevated particulate matter levels and public health effects is very well documented, scientists are still working to understand the precise biological

[6] The London fogs of the early 1950s that killed thousands of people were primarily caused by particulate matter from coal, which led to the banning of coal burning within the city.
[7] BAAQMD Advisory Council, 2020. Advisory Council Particulate Matter Reduction Strategy Report. December.
[8] BAAQMD, 2017. Final 2017 Clean Air Plan: Spare the Air – Cool the Climate. April.
[9] United States Environmental Protection Agency (EPA), 2018b. Integrated Science Assessment for Particulate Matter. October.
[10] EPA, 2018b. Integrated Science Assessment for Particulate Matter. October.

mechanisms through which particulate matter damages our health. Research studies have indicated several different potential mechanisms through which particulate matter can harm human health, including increases in blood pressure, blood vessel damage, tissue damage from oxidative stress, and DNA damage.[11,12] Recent research also indicates that early life exposure to wildfire smoke particulate matter can permanently damage the immune system and lung structure and function, and that this damage that can be passed to the next generation.[13]

c) *Health Benefits Analytical Techniques*

The Air District continues to study and evaluate health impacts associated with particulate matter exposure. The Air District developed a multi-pollutant evaluation method (MPEM) to analyze the benefits of control measures and strategies, such as the 2017 Clean Air Plan.[14] More recently, the Air District has applied the US Environmental Protection Agency's (EPA) Benefits Mapping and Analysis Program, Community Edition (BenMAP-CE) to estimate heath impacts of air pollution and to quantify the benefits of control measures. The BenMAP-CE program calculates the economic value of air quality change using conventional (EPA-approved) valuations, including both "cost of illness" and "willingness to pay" metrics. The techniques are further detailed in Appendices A.2 and A.3.

d) *General Findings of the Advisory Council*

In 2019, the Air District and the Air District's Advisory Council began convening a series of symposia on particulate matter and its health effects. The Advisory Council prepared a report of its findings and recommendations on ways to address particulate matter pollution and exposure, which was shared with the Air District Board of Directors during a special joint meeting with the Advisory Council on December 16, 2020. In its *Particulate Matter Reduction Strategy Report*, the Advisory Council concluded that current ambient air quality standards for particulate matter are not adequately health protective, and that further particulate matter reductions would realize additional health benefits.[15] Furthermore, the Advisory Council report states that the projected increased particulate matter exposure from wildfire smoke related to climate change justifies greater efforts to reduce controllable sources of particulate matter to reduce overall health risks. The report also states that particulate matter is the most important health risk driver in Bay Area air quality, and that there is no known threshold for harmful health effects from particulate matter in the form of $PM_{2.5}$. The Advisory Council also found that while some species of particulate matter may be more impactful than others, no particulate matter species can be exonerated from being considered dangerous to human health.

4. Current Emissions Control Technology and Methods

As discussed previously, particulate matter emissions from FCCUs include catalyst fines, particulates formed in the combustion process, and particulate matter formed from various gaseous components through condensation, nucleation, and coagulation processes. Therefore, control of total particulate matter emissions from these sources can depend on a variety of control equipment and methods to address these different components.

[11] BAAQMD, 2017. Final 2017 Clean Air Plan: Spare the Air – Cool the Climate. April.
[12] BAAQMD, 2012. Understanding Particulate Matter: Protecting Public Health in the San Francisco Bay Area. November.
[13] Miller, Lisa et al., 2019. "Are Adverse Health Effects from Air Pollution Exposure Passed on from Mother to Child?" University of California, Davis. California Air Resources Board Contract No. 15-303.
[14] BAAQMD, 2017. Final 2017 Clean Air Plan: Spare the Air – Cool the Climate. April.
[15] BAAQMD Advisory Council, 2020. Advisory Council Particulate Matter Reduction Strategy Report. December.

At Chevron Products Richmond, PBF Martinez Refinery, and Marathon Martinez Refinery, electrostatic precipitator (ESP) systems with ammonia injection are used at the fluidized catalytic cracking units as the primary control device to capture and remove catalyst fines and other particulate matter generated in the combustion process. In addition, these refineries use feed hydrotreatment and sulfur dioxide-reducing catalyst additives to reduce sulfur dioxide emissions and sulfur components that can contribute to particulate matter formation. At the Valero Benicia Refinery, a regenerative amine wet gas scrubber (WGS) is used at the fluidized catalytic cracking unit as the primary control device to abate particulate matter emissions and sulfur dioxide emissions that can contribute to particulate matter formation. Feed hydrotreatment is also used at the Valero Benicia Refinery. Further information on the operation of these control technologies is provided in Section II.C.

B. Regulatory History

1. Air District Rules/Regulations

The Air District has adopted a number of rules that address emissions of particulate matter from fluidized catalytic cracking units. Air District Regulation 6: Particulate Matter, Rule 1: General Requirements (Rule 6-1) contains an opacity limit of 20 percent for all sources, including fluidized catalytic cracking units and carbon monoxide boilers. Opacity is a measurement of the degree to which filterable particulates in an exhaust stream or dust plume obscure the ability of an observer to see through the exhaust stream or dust plume. Opacity can also be measured with instrumentation by the degree to which a beam of light can pass through the exhaust stream without being reflected by any particles in the exhaust stream. As such, opacity is a surrogate for more complicated and time intensive source testing (mass-based measurements) of particulate matter emissions. This method is fairly crude but easy to implement and was among the first methods used to measure and regulate particulate matter emissions.

The Air District adopted Regulation 6: Particulate Matter, Rule 5: Particulate Emissions from Refinery Fluidized Catalytic Cracking Units (Rule 6-5) in 2015, with the goal of reducing emissions of total particulate matter from fluidized catalytic cracking units at Bay Area refineries. Rule 6-5 established a limit for ammonia slip (unreacted ammonia emitted to atmosphere) of 10 parts per million, volumetric dry (ppmvd) at 3 percent oxygen (O_2), as a daily average. The Rule also provided for an alternative method of compliance for an owner or operator of a fluidized catalytic cracking unit to conduct an ammonia optimization study and establish an enforceable ammonia emission limit based on this optimization. Rule 6-5 was also amended in 2018 for minor clarifications, but no substantive changes were made to these ammonia injection and emission requirements.

Rule 6-5 does not currently contain sulfur dioxide emission limits, but the role of sulfur dioxide as a contributor to total particulate matter emissions (along with ammonia) was recognized during the development and adoption of the Rule in 2015, with the potential of addressing sulfur dioxide in future rule amendments. Air District Regulation 9: Inorganic Gaseous Pollutants, Rule 1: Sulfur Dioxide (Rule 9-1) does contain a sulfur dioxide limit for fluidized catalytic cracking units and prohibits the emission of effluent process gas containing sulfur dioxide in excess of 1,000 ppm by volume from a fluidized catalytic cracking unit. Additionally, Rule 9-1 contains general prohibitions on emissions of sulfur dioxide in quantities that result in ground level sulfur dioxide concentrations in excess of 0.5 ppm (continuously for three minutes), 0.25 ppm (averaged over 60 minutes), or 0.05 ppm (averaged over 24 hours).

In addition to existing regulations, the Air District's programmatic and plan-level efforts have identified and included measures and strategies to further reduce particulate matter emissions from fluidized catalytic cracking units.

e) 2017 Clean Air Plan

In 2017, the Air District adopted its current Clean Air Plan: Spare the Air, Cool the Climate (2017 Clean Air Plan or 2017 Plan). The 2017 Plan describes the Air District's approach to reducing emissions of air pollutants, including total particulate matter. The 2017 Plan includes control measures to protect the public health and reduce particulate matter, including stationary source Control Measure SS1: "Fluid Catalytic Cracking in Refineries." Control Measure SS1 includes establishing emission limits to reduce total particulate matter emissions at fluidized catalytic cracking units, working to conduct source tests and total particulate matter quantification, and evaluating ongoing progress in optimizing ammonia injection to minimize total particulate matter.

f) AB 617 Expedited BARCT Implementation Schedule

Assembly Bill 617 requires each air district that is in nonattainment for one or more air pollutants to adopt an expedited schedule for implementation of best available retrofit control technology (BARCT) by the earliest feasible date, but not later than December 31, 2023. "Best available retrofit control technology" is defined in the California Health and Safety Code as "…an emission limitation that is based on the maximum degree of reduction achievable, taking into account environmental, energy, and economic impacts by each class or category of source."[16] In December 2018, the Air District's Board of Directors adopted the AB 617 Expedited Best Available Retrofit Control Technology Implementation Schedule, which identified a number of potential rule development projects to evaluate and implement Best Available Retrofit Control Technology levels of emission control. The Schedule includes a rule development project to control emissions of total particulate matter from fluidized catalytic cracking units and carbon monoxide gas boilers. Staff identified strategies for addressing these emissions through potential amendments to Rule 6-5 that would address components of condensable particulate matter, including ammonia and sulfur dioxide.

2. Federal Regulations

Federal regulations that address emissions from fluidized catalytic cracking units and carbon monoxide boilers include the New Source Performance Standards (NSPS) Subparts J and Ja, and the National Emissions Standards for Hazardous Air Pollutants (NESHAP) Subpart UUU. The New Source Performance Standards Subpart J contains an emission limit of 1.0 kilograms of filterable particulate matter per megagram (kg/Mg) (2.0 lb/ton) of coke burnoff in the catalyst regenerator and an opacity limit of 30 percent. The New Source Performance Standards Subpart Ja has a filterable particulate matter emission limit of 1.0 g/kg of coke burnoff for fluidized catalytic cracking units reconstructed or modified after May 14, 2007, and a limit of 0.5 g/kg of coke burnoff for fluidized catalytic cracking units newly constructed after May 14, 2007. The National Emissions Standards for Hazardous Air Pollutants Subpart UUU includes various particulate matter emission limit options for compliance.

Note that these existing federal particulate matter limits are based on methods for monitoring and measuring filterable particulate matter only. The federal regulations do not contain limits for total particulate matter or ammonia slip; however, the federal New Source Performance Standards Subpart J contains sulfur dioxide emission limits of 9.8 kg/Mg (20 lb/ton) of coke burnoff, and 50 parts per million by volume (ppmv) sulfur dioxide for a fluidized catalytic cracking unit with an add-

[16] California Health and Safety Code, Section 40406.

on control device. The New Source Performance Standards Subpart Ja contains sulfur dioxide emission limits of 50 ppmv on a seven-day rolling average basis and 25 ppmv on a 365-day rolling average basis for fluidized catalytic cracking units constructed, reconstructed, or modified after May 14, 2007.

3. Existing Regulations in Other Districts

Staff reviewed existing rules in other air districts in California that address emissions of particulate matter from fluidized catalytic cracking units. In 2003, South Coast Air Quality Management District (South Coast AQMD) adopted Rule 1105.1: Reduction of PM_{10} and Ammonia Emissions from Fluid Catalytic Cracking Units. Units subject to Rule 1105.1 must meet one of the following limits for filterable PM_{10}: 3.6 pounds per hour, 0.005 grain per dry standard cubic foot corrected to 3 percent oxygen (O_2), or 2.8 pounds per thousand barrels of fresh feed. Rule 1105.1 also contains a provision that allows an operator to instead comply with a higher filterable PM_{10} emission limit of 0.006 grain per dry standard cubic foot, provided that the operator mitigates the difference in emission reductions between the 0.006 and 0.005 grain per dry standard cubic foot by other alternative methods. Note that these limits are based on methods for monitoring and measuring filterable particulate matter only. However, Rule 1105.1 does contain a limit for ammonia slip (unreacted ammonia emitted to atmosphere) of 10 parts per million, volumetric dry (ppmvd) at 3 percent oxygen (O_2) averaged over 60 consecutive minutes.

C. Technical Review of Emission Control Methods for Particulate Matter from Fluidized Catalytic Cracking Units

As discussed previously, flue gas components such as sulfur dioxide, oxides of nitrogen, and ammonia can contribute to total particulate matter emissions from fluidized catalytic cracking units. Therefore, many control strategies are available to reduce potential total particulate matter formation through the control of these components.

1. Reduction of Ammonia Injection and Ammonia Slip

Ammonia is commonly used as a conditioning agent to alter the resistivity and cohesiveness of particles in the gas stream, which can improve the effectiveness of electrostatic precipitators (ESP) in capturing catalyst fines. Excess ammonia that is not consumed in this process can remain in the fluidized catalytic cracking unit flue gas stream (this is called “ammonia slip”) and can combine with sulfur and nitrogen oxides in the stream to form particulate matter. Therefore, reducing ammonia injection and ammonia slip can reduce emissions of total particulate matter. Potential strategies for achieving these reductions include the optimization of ammonia injection, the use of alternative non-ammonia conditioning agents, and improved removal of particulate matter through electrostatic precipitators or wet gas scrubbing, which may reduce or eliminate the need for ammonia injection. Some of these control strategies may also be used in combination to effectively reduce emissions of total particulate matter.

a) Optimization of Ammonia Injection

The use of ammonia in existing abatement systems can be optimized to minimize the amount of ammonia injection and ammonia slip emissions. Optimization of ammonia injection can be achieved through proper process controls, data collection and monitoring, controls for injection timing, and regular maintenance and servicing of abatement equipment. The efficacy of ammonia optimization may be constrained by the capabilities and design of existing abatement equipment, which may vary widely between individual sources. Costs of ammonia optimization may include one-time optimization costs and additional ammonia and process monitoring systems, however reductions in ammonia use could result in long-term cost savings.

b) Use of Alternative Conditioning Agents

Ammonia and ammonia-based compounds (such as urea) are commonly used conditioning agents for improved removal of fluidized catalytic cracking unit catalyst fines at electrostatic precipitators. The use of non-ammonia-based compounds for flue gas conditioning could reduce or eliminate ammonia injection and associated ammonia slip emissions. Non-ammonia based conditioning agents used in other industrial applications include sulfur trioxide, sodium compounds, potassium sulfate, and steam injection. Proprietary chemicals have also been developed for flue gas conditioning in power and electricity generation applications. Costs of alternative conditioning agents are anticipated to be comparable to ammonia injection, although some cost differences between specific injection systems and chemicals would be expected. Limited information exists on the feasibility of alternative conditioning agents in refinery fluidized catalytic cracking unit applications.

c) Electrostatic Precipitator

An electrostatic precipitator (ESP) is a control device designed to remove particulate matter from an exhaust gas stream by using electrical energy. The main components of the electrostatic precipitator include discharge electrodes, collection plates, and a plate cleaning system. Particulate matter is removed from the gas stream through a series of steps inside the electrostatic precipitator: 1) a power supply energizes the discharge electrodes to establish an electric field; 2) the gas stream and particles are ionized and charged as they pass through the electric field; 3) the charged particles migrate out of the gas stream and towards collection plates, which are oppositely charged; and 4) the particles collected on the plates are removed for disposal. The removal of particles from the collection plates can be accomplished using different systems. In a dry electrostatic precipitator system, rapping systems are used to vibrate the collection plates and remove the collected particles. In a wet electrostatic precipitator system, particles are removed from the collection plates by rinsing the plates with water.

Ammonia is often injected into flue gas streams to improve the collection efficiency of the electrostatic precipitators, however excess ammonia in the flue gas stream (ammonia slip) can increase total particulate matter emissions. An electrostatic precipitator system with sufficient collection efficiency and capacity may be able to reduce or eliminate the need for ammonia injection, therefore limiting the amount of potential condensable particulate matter formation. The collection efficiency of an electrostatic precipitator system can be improved by rebuilding the system with additional capacity or by adding additional cells to increase residence time and collection surface area. In addition, advancements in electrostatic precipitator technologies can increase performance of existing systems, especially as these units and components age and degrade. Potential upgrades and replacements include rapping system upgrades, electrode upgrades, and power supply system upgrades. Rapping system upgrades (including rapping scheme optimization and enhanced control systems) can improve plate cleaning, which increases collection area and decreases re-entrainment of particles. Electrode upgrades (including electrode replacement, electrode spacing/configuration upgrades, and use of rigid discharge electrodes) can increase overall collection efficiency. Power supply system upgrades (including high frequency power supplies, switch-mode power supplies, and three-phase power supplies) can deliver higher and more consistent voltage to increase particulate matter collection.

For treatment of high-volume flue gas streams, installations of electrostatic precipitators typically require a large amount of space, although advancements in precipitator design and technology can reduce the size and space needed. Costs of new and expanded electrostatic precipitators can vary based on the specific installation, design, capacity, and other constraints. Costs for component replacements and upgrades to existing electrostatic precipitator systems would be anticipated to be much lower than the costs of a new electrostatic precipitator or electrostatic precipitator expansion. Potential costs and cost estimates for electrostatic precipitator controls are further discussed in Section V.B.

Potential hazards associated with electrostatic precipitators include risks for fire or explosion, which can occur if flammable hydrocarbons enter the unit and mix with oxygen in the presence of an ignition source. Standard industry practices and vendor safety recommendations, including frequent inspection and maintenance, air filter cleaning, use of hydrocarbon sensors, and electronic controls for process automation can reduce risks from operation of electrostatic precipitators. A well-documented incident involving a refinery electrostatic precipitator explosion occurred in February 2015 at the ExxonMobil Refinery located in Torrance, California. An investigation of the incident by the U.S. Chemical Safety and Hazard Investigation Board identified weaknesses in the refinery's process safety management system and found that a number of standard industry and safety practices were not followed, contributing to the incident.[17]

d) Wet Gas Scrubbing

Wet gas scrubbing is a process that is used to remove liquid or solid particles from a gas stream. The process removes these particles by transferring them to a liquid, which is typically water or a reagent solution. In a typical wet gas scrubbing system, the scrubbing liquid is sprayed into the spray tower, and the flue gas stream enters at the bottom of the tower and flows upwards through the scrubbing liquid. As the gas stream passes through the scrubbing liquid, particles from the stream are collected as they impact the liquid droplets. Some wet gas scrubbing systems are also designed to capture gaseous pollutants that can be absorbed into the scrubbing liquid. The scrubbing liquid is then collected by mist eliminators or separators for treatment and discharge, or for regeneration and further use. Various types of scrubbers exist with different features, such as tower design, spray operations, energy usage level, and liquid collection and regeneration systems. In addition to capturing filterable particulate matter, the wet gas scrubbing process can also remove condensable components, such as ammonia, as well as reduce or eliminate the need for ammonia injection altogether.

Costs of new wet gas scrubbing systems can vary based on specific design and site constraints, as well as additional equipment or infrastructure required for operation. Potential costs and cost estimates for wet gas scrubbing controls are further discussed in Section V.A.

Because the wet gas scrubbing process uses water or reagent solutions, these systems often require high volumes of water consumption. As the scrubbing liquid is passed through the scrubber, water is evaporated due to the high temperature of the flue gas stream. Spent scrubbing liquid that contains the captured pollutants also needs to be routed for treatment and discharge. Additional makeup water is therefore required to replace this lost water and maintain continued wet gas scrubbing operations. Estimated water demand for installations of wet gas scrubbers for fluidized catalytic cracking units in California range from 120,000 to 430,000 gallons per day.[18,19]

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[17] U.S. Chemical Safety and Hazard Investigation Board, 2017. Investigation Report – ExxonMobil Torrance Refinery Electrostatic Precipitator Explosion, Torrance, California. No. 2015-02-I-CA. May.
[18] City of Benicia, 2008. Valero Improvement Project – Addendum to VIP EIR, SCH No. 2002042122. June.
[19] South Coast AQMD, 2007. Final EIR for ConocoPhillips Los Angeles Refinery PM_{10} and NOx Reduction Project, SCH No. 2006111138. June.

Water consumption for each specific wet gas scrubbing system can vary based on a number of factors, including certain designs or technologies that can affect the need for makeup water. Pre-scrubber quench cooling systems can be used to reduce the temperature of the exhaust gas stream prior to entering the wet gas scrubber. This lowered gas temperature can reduce the amount of evaporation that occurs in the wet gas scrubber when the gas comes into contact with the scrubbing liquid. In addition, wet gas scrubbing systems utilizing regenerative technology can reduce the amount of spent scrubbing liquid that is purged and discharged. In a regenerative system, spent scrubbing liquid that contains the captured pollutant is routed to a separate section where the scrubbing liquid is separated from the pollutant and regenerated, typically through heating and condensing. The regenerated scrubbing liquid can then be re-used in the scrubbing system, reducing the amount of liquid purged and reducing the amount of makeup water needed. These types of designs and system elements typically involve increased capital costs and complexity due to additional equipment and space requirements.[20] In addition to these design and technology considerations, water demand requirements can be affected by the availability and use of water supplies other than fresh water, such as reclaimed and/or recycled water. Any other types of water used would still need to meet specific water quality standards required by the individual system design, as wet gas scrubbing equipment may be susceptible to water quality-related issues, such as deposit formation, high solids content and plugging of nozzles, and interferences with reagent chemistry. Therefore, the use of these other types of water stream would be dependent on the specific availability and treatment/infrastructure requirements associated with each individual system.

2. Reduction of Sulfur Dioxide Emissions

As discussed previously, sulfur dioxide emissions generated through the fluidized catalytic cracking unit catalyst regeneration process can also lead to increased total particulate matter emissions. Potential strategies for achieving reductions of sulfur dioxide and total particulate matter include the use and optimization of sulfur dioxide-reduction additives, feed hydrotreating, and removal of sulfur dioxide and particulate matter through wet gas scrubbing. Some of these control strategies may be used in combination to effectively reduce emissions of total particulate matter.

a) Optimization of Sulfur Dioxide-Reducing Additives

Sulfur dioxide-reducing additives are used to remove sulfur oxides from fluidized catalytic cracking unit regenerator flue gas. These additives typically consist of a metal oxide agent, such as a magnesium-based agent, and may contain other catalytic components. The sulfur dioxide removal process occurs through a multi-step mechanism. Sulfur dioxide is formed in the regenerator as coke is burned off the spent catalyst, and a portion of the sulfur dioxide is converted to sulfur trioxide (SO_3) in the presence of excess oxygen. The metal oxide agent chemically bonds with the sulfur trioxide to form a metal sulfate, which recirculates back to the reactor and reacts with hydrogen to form a metal oxide or a metal sulfide and water. The metal sulfide further reacts with steam to form a metal oxide and hydrogen sulfide. The hydrogen sulfide generated is routed for further treatment and sulfur recovery.

Optimized use of these additives can reduce sulfur dioxide emissions that contribute to total particulate matter emissions. In addition, advancements in additive technology and process controls may present additional potential for emissions reductions. Costs for optimizing sulfur dioxide-reducing additives may include one-time optimization costs and additional process

[20] Weaver, Edwin H. (BELCO Technologies Corporation), 2006. Evaluating Wet Scrubbers, Petroleum Technology Quarterly, Quarter 3, 2006.

monitoring and additive handling systems. Costs of different additives are anticipated to be comparable to existing additives, although optimized use of advanced additives may present some long-term cost savings from increased efficiency and reduced additive usage. Potential costs and cost estimates associated with these additives are further discussed in Section V.B.

b) Feed Hydrotreating

Removal of sulfur compounds in feed material prior to introduction to the fluidized catalytic cracking unit can reduce the amount of sulfur dioxide that is eventually generated through the fluidized catalytic cracking unit process. Refineries remove sulfur and other undesirable compounds from hydrocarbon feedstocks through feed hydrotreating. In the hydrotreatment process (also referred to as hydro-desulfurization), hydrogen is added to a feedstock stream over a bed of catalyst typically containing molybdenum with nickel or cobalt. Sulfur compounds in the feed react with hydrogen to form hydrogen sulfide (H_2S), which is then removed from the stream through an amine treatment system and routed to a sulfur recovery unit.

All refineries employ some form of feed hydrotreating, but additional treating or more severe hydrotreatment can further reduce sulfur content in the feed. The feasibility and costs of upgrades to existing hydrotreating systems can vary widely based on site-specific and operational considerations. These factors can include the condition, design, and capacity of the existing system, as well as the extent of upgrades being implemented. Potential costs and cost estimates associated with improved hydrotreatment controls are further discussed in Section V.B.

c) Wet Gas Scrubbing

Wet gas scrubbing is described above in Section II.C.1. For wet gas scrubbing systems that are designed to control sulfur dioxide, an alkaline reagent, such as caustic soda (NaOH), soda ash, or lime, is typically added to the scrubbing liquid. These reagents are used to drive sulfur dioxide absorption into the scrubbing liquid. As described previously, spent scrubbing liquid that contains the captured pollutants is then routed for treatment and discharge, or regenerated for further use.

III. PROPOSED AMENDMENTS

The purpose of the proposed amendments to Rule 6-5 is to further address particulate matter emissions, including condensable particulate matter emissions, from fluidized catalytic cracking units and associated carbon monoxide boilers. Air District staff reviewed and considered a variety of information in the development of the proposed amendments, including existing regulations, industry and academic literature, stakeholder input, emissions and compliance data, and information on control and monitoring technologies.

The proposed amendments include new and modified limits on ammonia and sulfur dioxide, as well as a direct limit on total PM_{10}, which includes both filterable and condensable particulate matter. The proposed new and modified limits reflect levels of stringency that have been achieved at units using wet gas scrubbing controls. The proposed amendments also include modifications to existing rule language to clarify provisions and improve monitoring requirements.

A. Purpose

The proposed amendments contain requirements to control total particulate matter and reduce flue gas components and pollutants known to increase total particulate matter emissions. The proposed amendments also contain testing and monitoring requirements to determine compliance with emission limits and provide further information on particulate matter emissions and control performance.

Section 6-5-101 – Description: The proposed amendments to Section 6-5-101 clarify the description of the rule consistent with the new and modified provisions and requirements of the proposed amendments to Rule 6-5 described below. The amendments to Section 6-5-101 also clarify the applicability of Rule 6-5 requirements to commingled emissions of an FCCU and other sources from a single exhaust point, consistent with existing provisions in Air District Regulation 1, Section 1-107. Air District Regulation 1, Section 1-107 states that where air contaminants from two or more sources are combined prior to emission and there are no adequate and reliable means to establish the nature, extent, and quantity of the emissions from each source, Air District regulations apply to the combined emission as if it originated in a single source, with emissions subject to the most stringent limitations and requirements applicable to any of the sources.

B. Applicability

Proposed amendments to Rule 6-5 would apply to fluidized catalytic cracking units and associated carbon monoxide boilers at Bay Area petroleum refineries. Four of the five petroleum refineries in the San Francisco Bay Area have fluidized catalytic cracking units.[21]

C. Exemptions

Section 6-5-111 – Limited Exemption, Emissions Abated by Wet Scrubber: The proposed amendments to Rule 6-5 modify the exemption under Section 6-5-111 regarding emissions abated by wet scrubber. Under the currently adopted Rule 6-5, emissions abated by a wet gas scrubber are not subject to any requirements of the rule. Because the proposed amendments include new requirements (described in the sections below), Section 6-5-111 is changed to a limited exemption to clarify that emissions abated by a wet scrubber are only exempt from the requirements related to ammonia limits in Section 6-5-301.1. Emissions abated by a wet scrubber would be subject to the additional limits and requirements included in these proposed amendments.

Section 6-5-112 – Limited Exemption, Emissions During Startup or Shutdown Periods: The proposed amendments to Rule 6-5 clarify the limited exemption under Section 6-5-112 for emissions during startup and shutdown periods. The amendments clarify that the exemption for these periods are only applicable to the short-term daily ammonia limit in Section 6-5-301.1 and short-term seven-day rolling average limit for sulfur dioxide in Section 6-5-301.2.2. Long-term limits in Section 6-5-301 would continue to apply.

Section 6-5-113 – Limited Exemption, Installation of Wet Scrubber: The proposed amendments to Rule 6-5 remove the language for this limited exemption. This limited exemption currently applies to owners or operators of an installed wet gas scrubber and provided an extension for compliance with the ammonia emission limit. The extension period has passed, and this limited exemption is no longer applicable.

Section 6-5-115 – Limited Exemption, Ammonia Optimization: The proposed amendments to Rule 6-5 modify the limited exemption under Section 6-5-115 regarding ammonia optimization. Under

[21] One of these four refineries is Marathon Martinez Refinery, which announced the temporary idling of their refinery, including the facility's FCCU, in April 2020. In July 2020, Marathon announced that the refinery will remain idled indefinitely with no plans to restart normal operations.

the currently adopted Rule 6-5, refinery operators that implement an optimization of ammonia and/or urea injection are exempt from the ammonia emission limit in Section 6-5-301.1. Under the proposed amendments, all sources previously exempt under Section 6-5-115 would be subject to the ammonia emission limit in Section 6-5-301.1, effective five years after the date of adoption.

D. Definitions

Section 6-5-212 – Total Particulate Matter 10 Microns or Less in Diameter (Total PM_{10}): The proposed amendments to Rule 6-5 define total particulate matter 10 microns or less in diameter (total PM_{10}) in Section 6-5-212 as material emitted to the atmosphere as filterable particulate matter or condensable particulate matter less than 10 microns in diameter. Condensable particulate matter is currently defined in the Rule under Section 6-5-203.

Section 6-5-213 – Total Particulate Matter 2.5 Microns or Less in Diameter (Total $PM_{2.5}$): The proposed amendments to Rule 6-5 define total particulate matter 2.5 microns or less in diameter (total $PM_{2.5}$) in Section 6-5-213 as material emitted to the atmosphere as filterable particulate matter or condensable particulate matter less than 2.5 microns in diameter. Condensable particulate matter is currently defined in the Rule under Section 6-5-203.

E. Standards

Section 6-5-301 – Fluidized Catalytic Cracking Unit (FCCU) Emission Limits: The proposed amendments to Rule 6-5 establish and modify fluidized catalytic cracking unit emission standards for ammonia slip, sulfur dioxide, and total particulate matter less than 10 microns in diameter. Under the proposed amendments, the proposed limits would become effective five years after the date of adoption. Staff anticipates that the proposed limits would require the installation of wet gas scrubbing systems at the affected refineries, which may involve substantial time and effort for the planning, design, scheduling, and construction and/or modifications associated with these abatement systems. For example, applications for use permits and Air District permits for the installation of the wet gas scrubber at the Valero Benicia Refinery were originally submitted in 2002 as part of the Valero Improvement Project. The Valero Improvement Project involved several components, and construction of the various elements occurred over several years following approval. Construction of the wet gas scrubber abatement train took place from 2008 through 2010, with operation commencing in 2011.[22] The ConocoPhillips Los Angeles Refinery (Wilmington) also installed a wet gas scrubber at the fluidized catalytic cracking unit to meet the requirements of South Coast AQMD's Rule 1105.1 adopted in 2003. Construction was reported to have occurred from 2007 through 2008.[23] Construction of a wet gas scrubber at the HollyFrontier Cheyenne Refinery fluidized catalytic cracking unit was reported to have occurred from 2014 through 2015, with planning of the project starting in 2011.[24,25]

Section 6-5-301.1: Under the proposed amendments, the ammonia emission limit of 10 parts per million by volume, dry basis (ppmvd) corrected to 3 percent oxygen on a daily average remains unchanged from the current Rule. As described above in the "Exemptions" section, the proposed

[22] Valero Benicia Refinery, 2012. Valero Improvement Project (VIP) Construction Report for the period ending June 30, 2012. August.
[23] South Coast AQMD, 2010. Final Staff Report SOx RECLAIM, Part 1: BARCT Assessment & RTC Reductions Analysis. November.
[24] HollyFrontier Cheyenne Refinery, 2015. "Cheyenne Can Breathe Easier." September.
[25] Orr, Becky, 2015. "Massive scrubber at HollyFrontier will cut pollution, stench," Wyoming Tribune Eagle. April 30.

amendments modify the limited exemption under Section 6-5-115 such that sources previously exempt from the ammonia emission limit in Section 6-5-301.1 would be subject to this limit effective five years after the date of adoption. The ammonia limit of 10 ppmvd is equivalent to the ammonia limit for fluidized catalytic cracking units adopted by South Coast Air Quality Management District in their Rule 1105.1; this limit was achieved by fluidized catalytic cracking units at multiple refineries in South Coast AQMD using electrostatic precipitators or wet gas scrubbers.

Sections 6-5-301.2.1 and 301.2.2: The proposed amendments include a new sulfur dioxide limit of 50 ppmvd corrected to zero (0) percent oxygen on a seven-day rolling average basis, and 25 ppmvd corrected to 0 percent oxygen on a 365-day rolling average basis. These limits are equivalent to the sulfur dioxide limits in the federal New Source Performance Standards Subpart Ja, which are required for fluidized catalytic cracking units constructed, reconstructed, or modified after May 14, 2007. These sulfur dioxide emission levels have been achieved at multiple refineries throughout California and the United States through the implementation of sulfur dioxide-reducing additives, wet gas scrubbers, or both. In addition, the wet gas scrubbing system in operation at the Valero Benicia Refinery is currently subject to comparable sulfur dioxide limits. The proposed amendments include an effective date five years after the date of adoption.

Section 6-5-301.3: The proposed amendments include a new limit for total PM_{10}. The proposed amendments require the operator of a fluidized catalytic cracking unit to comply with a total PM_{10} limit of 0.010 grains per dry standard cubic foot (gr/dscf) at 5 percent oxygen on a rolling four-quarter average basis. The total PM_{10} limit in the proposed amendments is based on the Air District's review of source test data from fluidized catalytic cracking units at refineries throughout California and the United States. A summary of this data is provided in Appendix B. The proposed total PM_{10} limit of 0.010 gr/dscf at 5 percent oxygen represents an achievable level of control that has been demonstrated to be feasible at multiple facilities through the use of wet gas scrubbers. The proposed amendments include an effective date for the total PM_{10} limit five years after the date of adoption.

Under the proposed amendments, compliance with the total PM_{10} limits would be determined based on the rolling four-quarter average calculated as the time-weighted average of source tests (which must be performed on at least a quarterly basis). Other emission monitoring systems approved by the Air District would also be allowed for monitoring and compliance demonstration with the total PM_{10} limit.

F. Administrative Requirements

Section 6-5-403 – Ammonia Optimization: The proposed amendments include clarifications and modifications to the ammonia optimization requirements in Section 6-5-403 to align this section with the provisions and timelines of the proposed amendments in Section 6-5-115.1.

Section 6-5-404 – Reporting Requirements: Proposed Section 6-5-505 requires monthly reporting of monitoring and source test data collected as required by Sections 6-5-501 and 503.

G. Monitoring and Records

The owner or operator of any source subject to the emission limits in Section 6-5-301 must monitor and record all parameters necessary to demonstrate compliance with the applicable standards.

Section 6-5-501 – Ammonia Monitoring: For fluidized catalytic cracking units subject to the ammonia emission limit in Section 6-5-301.1, ammonia monitoring requirements in Section 6-5-501 remain unchanged from the current Rule.

Section 6-5-502 – Sulfur Dioxide Monitoring: Under proposed Section 6-5-502, refinery operators that must comply with the proposed sulfur dioxide limits in Section 6-5-301.2 must also comply with the continuous emission monitoring requirements of Air District Regulation 1: General Provisions and Definitions, Sections 1-520 and 522.

Section 6-5-503 – Total PM_{10} and Total $PM_{2.5}$ Monitoring: Under proposed Section 6-5-503, refinery operators that must comply with the total PM_{10} limit in Section 6-5-301.3 must also implement a source testing protocol or other total PM_{10} and total $PM_{2.5}$ emission monitoring system approved by the Air District. The source testing protocol must include at least one source test each calendar quarter for total PM_{10} and total $PM_{2.5}$ emissions in accordance with Sections 6-5-604 and 605.

Section 6-5-504 – Records: The proposed amendments to Section 6-5-504 extend the current recordkeeping requirements to include all monitoring records required under Sections 6-5-501, 502, and 503. Section 6-5-504 has also been renumbered accordingly.

H. Manual of Procedures

Section 6-5-601 – Compliance Determination: The proposed amendments to Section 6-5-601 include additional provisions regarding the performance of source tests for compliance. Under the proposed amendments, source tests must meet the requirements in the Air District Manual of Procedures, Volume IV, Source Test Policy and Procedures. The proposed amendments to Section 6-5-601 also include clarifications to align this section with the proposed amendments in Section 6-5-112 pertaining to emissions during startup and shutdown periods. The amendments clarify that the exemption for these periods is only applicable to the short-term daily ammonia limit in Section 6-5-301.1 and short-term seven-day rolling average limit for sulfur dioxide in Section 6-5-301.2.2.

Section 6-5-602 – Determination of Ammonia and Oxygen: The proposed amendments to Section 6-5-602 specify additional requirements for Air District approved ammonia monitoring systems. Under the proposed amendments, ammonia monitoring systems must meet the applicable requirements for ammonia monitoring in the Air District Manual of Procedures. The Air District is currently evaluating and developing performance specifications that can be applied to ammonia monitoring systems, and any future relevant updates to the Air District Manual of Procedures would be applicable to these monitoring systems. The proposed amendments also clarify that compliance with the ammonia limits in Section 6-5-301.1 must be determined by the monitoring systems installed as required by Section 6-5-501.

Section 6-5-603 – Determination of Sulfur Dioxide: Proposed Section 6-5-603 requires that compliance with the sulfur dioxide limits in Section 6-5-301.2 be determined by monitoring systems that meet the requirements of Air District Regulation 1, Section 1-522.

Section 6-5-604 – Determination of Total Particulate Matter 10 Microns or Less in Diameter (Total PM_{10}): Proposed Section 6-5-604 requires that total PM_{10} be determined by the summation of filterable PM_{10} as measured by US Environmental Protection Agency Test Method 201A and condensable particulate matter as measured by US Environmental Protection Agency Test

Method 202. Compliance with the total PM_{10} limit in Section 6-5-301.3 must be determined by the time-weighted average of all source tests conducted in the preceding four calendar quarters.

Section 6-5-605 – Determination of Total Particulate Matter 2.5 Microns or Less in Diameter (Total $PM_{2.5}$): Proposed Section 6-5-605 requires that total $PM_{2.5}$ be determined by the summation of filterable $PM_{2.5}$ as measured by US Environmental Protection Agency Test Method 201A and condensable particulate matter as measured by US Environmental Protection Agency Test Method 202.

IV. EMISSIONS AND EMISSION REDUCTIONS

As described previously, the fluidized catalytic cracking unit regeneration process generates particulate matter emissions through the combustion process and through the loss of catalyst fines. In addition, other pollutants in the regenerator flue gas, including sulfur dioxide, oxides of nitrogen, and ammonia, can increase total particulate matter. When the plume from the stack cools, these components can form various particles, including ammonium nitrates and ammonium sulfates. As the formation of total particulate matter is complex, emission estimates can be informed by a variety of data, including source process parameters, source testing, and monitoring of total particulate matter components. Air District staff estimates of total particulate matter emissions from fluidized catalytic cracking units in the San Francisco Bay Area for calendar year 2018 are shown in Table 1. Air District staff continues to study these emissions and gather additional information as appropriate. As part of this effort, Air District staff conducted and oversaw further source testing at the PBF Martinez Refinery fluidized catalytic cracking unit from September to October 2020. Source test results demonstrated reasonable agreement with previous total PM_{10} emission estimates.

A. Emissions

As shown in Table 1, emissions from petroleum refinery fluidized catalytic cracking units total approximately 825 tons per year of PM_{10} and 800 tons per year of $PM_{2.5}$. These emissions contribute to approximately 50 percent of all refinery PM_{10} emissions, represent approximately 17 percent of PM_{10} emissions from all inventoried stationary sources at facilities with Air District permits, and 3 percent of all human-made PM_{10} emissions in the Bay Area.

Table 1 – Particulate Matter Emissions from Petroleum Refinery Fluidized Catalytic Cracking Units by Facility

Facility	FCCU Fresh Feed Capacity (barrels per day)[26]	PM_{10} (tons per year)	$PM_{2.5}$ (tons per year)
Chevron Products Richmond[a]	80,000	245	229
Marathon Martinez Refinery[b,c]	*70,000*	*190*	*190*
PBF Martinez Refinery[a]	67,400	309	300
Valero Benicia Refinery[d]	72,000	81	81
Total[e]	**289,400**	**825**	**800**

[a] Emissions based on reported 2018 facility emissions inventory for total PM.
[b] Reported 2018 facility emissions inventory only included filterable PM. Emissions shown here are based on average 2020 source test emission rate data for total PM. $PM_{2.5}$ emissions were assumed to be equal to PM_{10} emissions.
[c] The Marathon Martinez Refinery announced the idling of the refinery, including the facility's fluidized catalytic cracking unit, in April 2020. Marathon announced in July 2020 that the facility would remain indefinitely idled with no plans to restart.
[d] Reported 2018 facility emissions inventory only included filterable PM. Emissions shown here are based on average 2016-2019 source test emission rates data for total PM at flue gas scrubber stack, which includes combined emissions from Valero's fluidized catalytic cracking unit and coker unit. $PM_{2.5}$ emissions were assumed to be equal to PM_{10} emissions.
[e] Total figures shown include the Marathon Martinez Refinery, which was idled in April 2020 and remains indefinitely idled.

B. Emission Reductions

Based on staff's understanding of fluidized catalytic cracking units emissions and performance at the Bay Area petroleum refineries, staff anticipates that fluidized catalytic cracking units at Chevron Products Richmond, Marathon Martinez Refinery, and PBF Martinez Refinery would not meet the proposed emission limits, and staff anticipates that emission reductions would be required at these facilities to comply with these proposed limits. Staff anticipates that the fluidized catalytic cracking unit at Valero Benicia Refinery would be able to comply with the proposed emission limits without substantial modifications, and potential emission reductions at this facility would be minimal. Estimates of potential emission reductions associated with the proposed limits are shown in Table 2.

Table 2 – Estimates of Potential Particulate Matter Emission Reductions under Proposed Amendments

Facility	Estimated PM_{10} Reductions (tons per year)
Chevron Products Richmond	160
Marathon Martinez Refinery[a]	*93*
PBF Martinez Refinery	240
Valero Benicia Refinery	–
Total Estimated Reductions[b]	**493**

[a] The Marathon Martinez Refinery announced the idling of the refinery, including the facility's fluidized catalytic cracking unit, in April 2020. Marathon announced in July 2020 that the facility would remain indefinitely idled with no plans to restart.
[a] Total estimated reductions shown include potential reductions at the Marathon Martinez Refinery, which was idled in April 2020 and remains indefinitely idled.

[26] U.S. Energy Information Administration, 2019. Refinery capacity data by individual refinery as of January 1, 2019. https://www.eia.gov/petroleum/data.php.

V. ECONOMIC IMPACTS

A. Cost Effectiveness

The Air District is required to consider cost effectiveness when adopting any regulation.[27] Cost effectiveness is calculated by dividing the annualized costs (amortized capital costs and operating costs) by the total number of tons of emission reductions expected each year:

$$\text{Cost-effectiveness} = \frac{\text{Annualized cost}}{\text{Annual Emission reduction}}$$

Air District staff reviewed available data on costs and cost estimation tools and methodologies and developed cost estimates associated with compliance under the proposed amendments. Based on these cost estimates, Air District staff estimated cost effectiveness for the proposed amendments. Estimates of the total compliance costs, total annual costs, and cost effectiveness are shown in Table 3. Further information and details on the development of the cost estimates are provided in the following Section V.A.1.

Table 3 – Compliance Cost and Cost Effectiveness Estimates for Proposed Amendments

Facility	Estimated Capital Costs	Estimated Total Annual Costs[a]	Estimated Cost Effectiveness
Chevron Products Richmond	$241 MM	$39 MM	$242,700
Marathon Martinez Refinery[b]	*$235 MM*	*$38 MM*	*$406,400*
PBF Martinez Refinery	$255 MM	$40 MM	$165,000
Valero Benicia Refinery	–	–	–

[a] Total annualized costs include amortized capital costs, tax, insurance, general and administrative, and operating and maintenance costs.
[b] The Marathon Martinez Refinery announced the idling of the refinery, including the facility's fluidized catalytic cracking unit, in April 2020. Marathon announced in July 2020 that the facility would remain indefinitely idled with no plans to restart.

Air District staff has also reviewed information on cost effectiveness data of previously adopted rules and amendments for particulate matter. This data is provided in Table 4 for additional information and context.

[27] California Health and Safety Code, Section 40703.

Table 4 – Historical Cost Effectiveness Data for Previously Adopted Rules and Amendments

District	Rule/Amendment (Year)	Pollutant	Cost Effectiveness Data (2019 Dollars)
BAAQMD	Rule 6-1 Amendments – General Requirements (2018)	Total Suspended Particulate (TSP)	$2,500/ton - $14,000/ton
BAAQMD	Rule 6-6 – Prohibition of Trackout (2018)	PM_{10}	$4,700/ton
		$PM_{2.5}$	$32,500/ton
SCAQMD	Rule 1105.1 Amendments – FCCUs (2003)	Filterable PM	$19,600/ton - $34,800/ton
		Filterable and Condensable PM	$4,500/ton - $7,600/ton
SCAQMD	Rule 1158 Amendments – Coke/Coal/Sulfur Handling (1999)	PM_{10}	$4,700/ton - $46,700/ton

Note: This table does not list other recent Air District rulemakings that reduced particulate matter that did not have relevant cost effectiveness data. This includes Rule 9-13: Nitrogen Oxides, Particulate Matter, and Toxic Air Contaminants from Portland Cement Manufacturing (2012), Rules 12-13: Foundry and Forging Operations (2013), Rule 6-4: Metal Recycling and Shredding Operations (2013), and Rule 6-5: Particulate Emissions from Refinery Fluidized Catalytic Cracking Units (2015).

1. Development of Compliance Cost Estimates for Proposed Amendments

Under the proposed amendments, staff anticipates that additional pollution abatement equipment and modifications would be required at fluidized catalytic cracking units at Chevron Products Richmond, PBF Martinez Refinery, and Marathon Martinez Refinery. Based on staff's understanding of current performance and emissions at these facilities, staff anticipates that wet gas scrubbing systems would be required to comply with the proposed emission limits.

Staff estimated costs for wet gas scrubbing systems using control cost methodologies presented in the US Environmental Protection Agency Air Pollution Control Cost Manual.[28] Staff assumed non-regenerative wet gas scrubbers would be applied to an exhaust flow of approximately 550,000 actual cubic feet per minute at Chevron Products Richmond; 530,000 actual cubic feet per minute at Marathon Martinez Refinery; and 480,000 actual cubic feet per minute at PBF Martinez Refinery.[29] Additional assumptions, inputs, and model parameters were based on the cost estimates and methodologies for non-regenerative wet gas scrubbers presented in the EPA cost analysis for the 2008 Standards of Performance for Petroleum Refineries.[30]

Staff also applied additional adjustments to the results of these methodologies to reflect temporal and geographic equipment cost and wage differences and changes in market conditions. To adjust for inflation and changes of control costs over time, staff used the Chemical Engineering Plant Cost Index (CEPCI) to adjust cost estimates to 2019 dollars.[31] The Chemical Engineering Plant Cost Index is an index that tracks costs of equipment, construction labor, buildings, and supervision in chemical process industries, and has been used extensively by the US

[28] United States Environmental Protection Agency (EPA), 2018a. EPA Air Pollution Control Cost Manual. https://www.epa.gov/economic-and-cost-analysis-air-pollution-regulations/cost-reports-and-guidance-air-pollution. Updated May 23, 2018.
[29] PBF Martinez Refinery is currently configured to exhaust gas through three separate carbon monoxide boilers. Staff assumes that these exhaust streams would be combined and routed to a single wet gas scrubber in this control scenario.
[30] EPA, 2008. Regulatory Impact Analysis for the Proposed Petroleum Refinery New Source Performance Standards, EPA–452/R–07–006.
[31] Chemical Engineering, 2020. The Chemical Engineering Plant Cost Index. https://www.chemengonline.com/pci-home.

Environmental Protection Agency for escalation purposes.[32] Staff also reviewed information on potential adjustments to account for regional market differences. Staff found that construction costs for projects in the San Francisco Bay Area are approximately 30 percent higher compared to national average costs based on a review of the RSMeans City Cost Index, which allows for comparison of materials, labor, and installation costs across different regions.[33] Although the index is not specific to air pollution control equipment, it provides a reference point for comparison of these costs between regional markets.

In addition, staff reviewed information from the Valero Benicia Refinery's installation of a regenerative wet gas scrubber to evaluate the performance of the cost estimate methodology and identify other potential adjustments and refinements. The Valero Benicia Refinery installed a regenerative wet gas scrubber to abate emissions from the facility's fluidized catalytic cracking unit and fluid coking unit. This project is the most recent installation of a wet gas scrubber on a fluidized catalytic cracking unit in California, and the only such refinery wet gas scrubber in the San Francisco Bay Area. Valero reported that the cost of the wet gas scrubber equipment train, which also included the replacement of existing furnaces, was approximately $750 million.[34] The cost of the wet gas scrubber installation was estimated to be approximately $525 million.[35] Staff conducted a comparison of this reported cost with cost estimates developed for a comparably sized regenerative wet gas scrubbing system using US Environmental Protection Agency control cost methodologies. Staff's evaluation indicated that reported costs were a factor of seven higher than the estimates developed using the US Environmental Protection Agency control cost methodologies for the comparable system. Staff applied this additional factor to the compliance cost estimates for the proposed amendments.

Staff also solicited input from potentially affected refineries on estimated costs related to the installation of a wet gas scrubber. Based on staff's understanding of potential space constraints at PBF Martinez Refinery in the areas around the existing fluidized catalytic cracking unit and carbon monoxide boilers, staff assumes the installation of a wet gas scrubber would require additional costs for the relocation of some equipment. Based on staff's understanding and stakeholder input, staff estimated that this relocation would cost approximately $35 million. Staff included this additional relocation cost in the cost estimates for the PBF Martinez Refinery. Chevron Products Richmond also expressed concerns regarding siting constraints at their refinery, but did not provide further details on specific relocation costs for consideration in staff's analysis.

Capital cost estimates for wet gas scrubber installations for each facility are shown in Table 3. Staff also estimated total annual costs, which includes amortized capital costs, tax, insurance, general and administrative (G&A) costs, and operating and maintenance (O&M) costs. Amortized capital cost is calculated assuming a project lifetime of 20 years at six percent interest. Operating and maintenance costs were estimated based on the US Environmental Protection Agency cost estimating methodologies and assumptions described previously. Other annual costs were estimated as a percentage of capital cost, with tax costs of one percent, insurance costs of one

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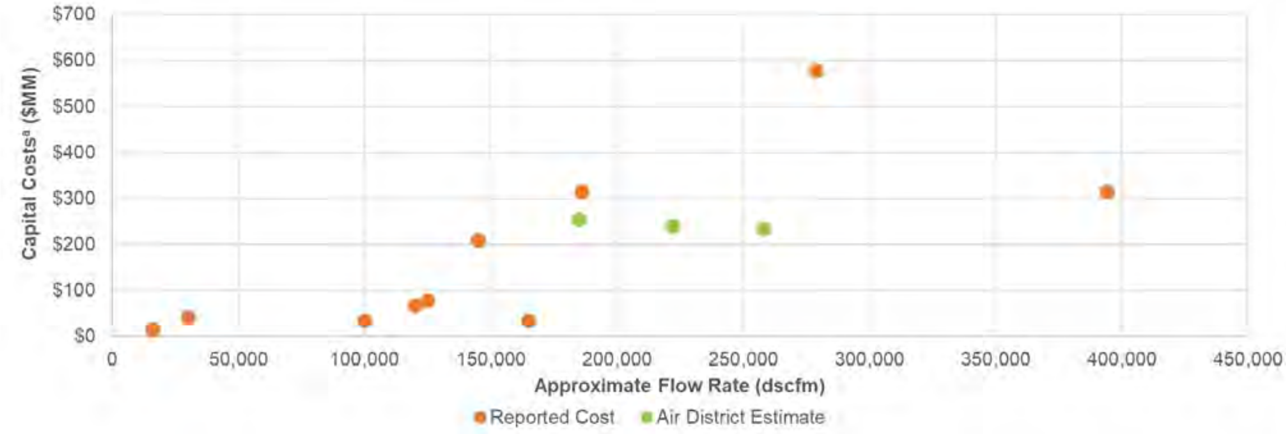
[32] EPA, 2018a. EPA Air Pollution Control Cost Manual. https://www.epa.gov/economic-and-cost-analysis-air-pollution-regulations/cost-reports-and-guidance-air-pollution. Updated May 23, 2018.
[33] Gordian, 2020. RSMeans City Cost Index. https://www.rsmeans.com/rsmeans-city-cost-index.
[34] Valero Benicia Refinery, 2012. Valero Improvement Project (VIP) Construction Report for the period ending June 30, 2012. August.
[35] Gas Prices: Hearing before the U.S. Senate Committee on Energy and Natural Resources, 113th Cong. 22, 2013. (Prepared Statement of William R. Klesse, Chairman of the Board and Chief Executive Officer, Valero Energy Corporation, San Antonio, TX.)

percent, and general and administrative costs of two percent. The estimates of total annual costs, including amortized capital and annual operating costs, are also shown in Table 3.

To provide further context for these cost estimates, staff also reviewed available cost information reported for refinery wet gas scrubber installations at other facilities throughout the US. Staff collected available reported cost information for refinery wet gas scrubbing systems, and applied factors to adjust cost data to 2019 dollars and the California region where appropriate to provide a more standardized basis for comparison. Staff recognizes that there are many other potential factors that can impact capital costs of these systems, including but not limited to specific design and configuration of the source being abated, wet gas scrubbing system design, additional equipment and/or equipment modifications required. Nevertheless, these reported costs can provide information on the types of costs that have been historically incurred. This cost information is shown in Figure 2 and summarized in Table 5, along with approximate flow rates for the wet gas scrubbing units in dry standard cubic feet per minute (dscfm) to provide an indication of the size and capacity of each system. The cost estimates for Chevron Products Richmond, Marathon Martinez Refinery, and PBF Martinez Refinery are also shown in Figure 2.

Figure 2 – Summary of Refinery Wet Gas Scrubber Capital Costs



[a] Capital costs shown were adjusted to year 2019 dollars and California market cost basis where appropriate.

Table 5 – Adjusted Capital Costs of Refinery Wet Gas Scrubbing System Installations

Installation/ Operational Year	Facility/Unit	Reported Capital Cost, Adjusted[a]	Approximate Flow Rate (dscfm)[b]
2011	HollyFrontier Woods Cross Unit 4 FCCU #1[36]	$16 MM	16,000
2015	HollyFrontier Cheyenne FCCU[37]	$43 MM	30,000
2004	Tesoro Mandan FCCU[38]	$36 MM	100,000
2008	Unspecified SCAQMD Refinery X FCCU[39]	$68 MM	120,000
2006	Shell Puget Sound Refinery FCCU[40]	$79 MM	125,000
2007	CITGO Lemont FCCU[41]	$210 MM	145,000
2004	Shell Deer Park FCCU[42]	$36 MM	165,000
2006	Valero Delaware City Refinery Coker[43]	$316 MM	186,000
2010	Valero Benicia FCCU and Coker[44]	$579 MM	280,000
2006	Valero Delaware City Refinery FCCU[45]	$316 MM	394,000

[a] Capital costs shown were adjusted to year 2019 dollars and California market cost basis where appropriate.
[b] dscfm = dry standard cubic feet per minute

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[36] HollyFrontier Corporation, 2011. Form 10-K (Annual Report), Filed 02/25/11 for the Period Ending 12/31/10.
[37] HollyFrontier Cheyenne Refinery, 2015. "Cheyenne Can Breathe Easier." September.
[38] Bismarck Tribune, 2004. "Tesoro installs a new $2[0] million scrubber." October 26.
[39] South Coast AQMD, 2010. Final Staff Report SOx RECLAIM, Part 1: BARCT Assessment & RTC Reductions Analysis. November.
[40] Anacortes Chamber of Commerce, 2012. "Shell Puget Sound Refinery," The Anacortes Communicator. July.
[41] CITGO Petroleum Corporation and PDV Midwest Refining, LLC., v. Illinois Environmental Protection Agency, 2013. Petition for Modification of Variance to Include Additional Conditions for Protection of Aquatic Life Uses. July 10.
[42] Vanya, Rob, 2004. "Shell going to great lengths to meet environmental mandates," Houston Chronicle. September 13.
[43] BAAQMD, 2008. Tesoro Plant No. 14628, Banking Application No. 17798 Engineering Evaluation. November.
[44] Gas Prices: Hearing before the U.S. Senate Committee on Energy and Natural Resources, 113th Cong. 22, 2013. (Prepared Statement of William R. Klesse, Chairman of the Board and Chief Executive Officer, Valero Energy Corporation, San Antonio, TX.)
[45] BAAQMD, 2008. Tesoro Plant No. 14628, Banking Application No. 17798 Engineering Evaluation. November.

Staff also sought input from potentially affected refineries on the potential costs of a wet gas scrubbing system. Chevron Products Richmond estimates that the installation of a wet gas scrubber would result in total capital costs of approximately $1.48 billion. PBF Martinez Refinery estimates that the installation of a wet gas scrubber would result in total capital costs of approximately $800 million. These estimates are substantially higher than the costs estimated by Air District staff and are higher than any of the adjusted costs reviewed for other refinery wet gas scrubber installations.

During previous public comment periods for materials related to this rule development effort, staff received many public comments about potential wet gas scrubbing designs and technologies that could reduce potential water usage. As described in Section II.C.1, several technologies are available to reduce wet gas scrubber water usage, but typically result in increased costs and complexity. Due to the increased costs, staff does not anticipate that the affected facilities would elect to implement these designs; nevertheless, staff have developed information on potential costs associated with these types of technologies. Literature suggests that the use of a regenerative wet gas scrubber design would increase initial capital costs compared to a non-regenerative design due to additional equipment required, but would result in some operational cost savings due to the reductions in water use and associated wastewater handling and processing.[46] Applying these capital cost and operating cost adjustments to the non-regenerative cost model, staff estimates that costs for a regenerative wet gas scrubber would be approximately $579 million at Chevron Products Richmond ($76 million total annual cost), $565 million at Marathon Martinez Refinery ($75 million total annual cost), $563 million at PBF Martinez Refinery ($74 million total annual cost). As mentioned, staff does not anticipate that the affected facilities would elect to implement these costlier technologies.

B. Incremental Cost Effectiveness

The California Health and Safety Code requires the Air District to consider incremental cost effectiveness of potential control options identified that meet the emission reduction objectives of the regulation.[47] Incremental cost effectiveness is calculated by: 1) calculating the incremental difference in cost between the identified control methods, and 2) dividing the incremental difference in cost by the incremental difference in emission reductions between each progressively more stringent potential control option:

$$\text{Incremental cost-effectiveness} = \frac{\text{Annual cost (B)} - \text{Annual cost (A)}}{\text{Emission reduction (B)} - \text{Emission reduction (A)}}$$

Air District staff identified a potential control option that is less stringent and less costly than the proposed control option and developed associated emission reduction estimates and cost estimates (further information and details on this less stringent control option and associated cost estimates are provided in the following Section V.B.1). Air District staff estimated the incremental cost effectiveness of the proposed amendments compared to this less stringent control option. The results of this incremental cost effectiveness analysis are shown in Table 6.

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[46] Weaver, Edwin H. (BELCO Technologies Corporation), 2006. Evaluating Wet Scrubbers, Petroleum Technology Quarterly, Quarter 3, 2006.
[47] California Health and Safety Code, Section 40920.6.

Table 6 – Incremental Cost Effectiveness Analysis for Proposed Amendments and Other Control Options

Facility	Capital Costs	Total Annual Costs[a]	PM_{10} Emission Reductions (tpy)	Cost Effectiveness ($/ton)	Incremental Cost Effectiveness ($/ton)
Proposed Amendments					
Chevron Products Richmond	$241 MM	$39 MM	160	$242,700	$430,200
Marathon Martinez Refinery[b]	*$235 MM*	*$38 MM*	*93*	*$406,400*	*–*[c]
PBF Martinez Refinery	$255 MM	$40 MM	240	$165,000	$359,400
Valero Benicia Refinery	–	–	–	–	–
Less Stringent Control Option					
Chevron Products Richmond	$30 MM	$4.4 MM	80	$55,300	–
Marathon Martinez Refinery[b]	*–*	*–*	*–*	*–*	*–*
PBF Martinez Refinery	$80 MM	$14 MM	170	$84,900	–
Valero Benicia Refinery	–	–	–	–	–

[a] The total annualized costs include amortized capital costs, tax, insurance, general and administrative, and operating and maintenance costs.
[b] The Marathon Martinez Refinery announced the idling of the refinery, including the facility's fluidized catalytic cracking unit, in April 2020. Marathon announced in July 2020 that the facility would remain indefinitely idled with no plans to restart.
[c] Incremental cost effectiveness is not calculated for the Marathon Martinez Refinery because there is no emission reduction or compliance cost under the less stringent control option to compare to the proposed amendments.

1. Development of Compliance Cost Estimates for Less Stringent Control Option

Air District staff identified a less stringent control option as a potential alternative to the proposed amendments. This less stringent control option was previously discussed as "Control Scenario A" in the Air District's Workshop Report released in January 2021.[48] This control option reflects levels of control that are less stringent than the proposed amendments and have been demonstrated to be feasible through the use of various control technologies, including electrostatic precipitators.

For this analysis, staff assumed that facilities would be required to meet a less stringent total PM_{10} limit of 0.020 grains per dry standard cubic foot (gr/dscf). Based on staff's understanding of fluidized catalytic cracking units emissions and performance at the refineries, staff anticipated that the fluidized catalytic cracking units at Chevron Products Richmond and PBF Martinez Refinery would not meet the this limit, and emission reductions would be required at these facilities. Estimates of these potential emission reductions associated with the less stringent control option are shown in Table 6. Staff anticipated that the fluidized catalytic cracking units at Marathon Martinez Refinery and Valero Benicia Refinery would be able to comply with these emission limits without substantial modifications; potential emission reductions at these facilities would, therefore, be minimal under this less stringent control option.

Staff anticipated that additional pollution abatement equipment and modifications would be required at fluidized catalytic cracking units at Chevron Products Richmond and PBF Martinez Refinery. Based on staff's understanding of current performance and emissions at these facilities, staff anticipated that improvements to existing electrostatic precipitator systems or additional electrostatic precipitator capacity would be required under this control option. Staff anticipated that PBF Martinez Refinery would also be required to improve feed hydrotreatment and sulfur

[48] BAAQMD, 2021. Workshop Report – Draft Amendments to Regulation 6, Rule 5: Particulate Emissions from Petroleum Refinery Fluidized Catalytic Cracking Units. January.

dioxide-reducing additives under this control option. Estimates of the total compliance costs and cost effectiveness under this less stringent control option are shown in Table 7. Further information and details on the development of these cost estimates are provided below.

Table 7 – Estimates of Compliance Costs and Cost Effectiveness for Less Stringent Control Option

Facility	Estimated Capital Costs	Estimated Total Annual Costs[a]	Estimated Cost Effectiveness
Chevron Products Richmond[b]	$30 MM	$4.4 MM	$55,300/ton
Marathon Martinez Refinery	–	–	–
PBF Martinez Refinery[c]	$80 MM[d]	$14 MM[e]	$84,900/ton
Valero Benicia Refinery	–	–	–

[a] Total annualized costs include amortized capital costs, tax, insurance, general and administrative, and operating and maintenance costs.
[b] Compliance costs at Chevron Products Richmond include improvements/expansions to existing electrostatic precipitator systems.
[c] Compliance costs at PBF Martinez Refinery include improvements/expansions to existing electrostatic precipitator systems, improvements to existing feed hydrotreatment systems, and optimized/improved sulfur dioxide-reducing additives.
[d] Includes capital costs of $40 million for improvements/expansions to existing electrostatic precipitator systems and $40 million for improvements to existing feed hydrotreatment systems.
[e] Includes annual costs of $5.9 million per year for improvements/expansions to existing electrostatic precipitator systems and $7.1 million per year for improvements to existing feed hydrotreatment systems, and $1.5 million per year for optimized/improved sulfur dioxide-reducing additives.

a) Cost Estimates for Electrostatic Precipitator Improvements

Staff estimated costs for electrostatic precipitator expansions using control cost methodologies presented in the EPA Air Pollution Control Cost Manual.[49] Staff assumed controls would be applied to an exhaust flow of approximately 550,000 actual cubic feet per minute at Chevron Products Richmond, and applied to three separate exhaust flows of approximately 160,000 actual cubic feet per minute each at PBF Martinez Refinery due to the configuration of the fluidized catalytic cracking system and three carbon monoxide boilers at the refinery. Due to the existing electrostatic precipitator systems at both facilities, staff estimated costs for expansions of these systems based on a half-sized electrostatic precipitator. Additional assumptions, inputs, and model parameters were based on the cost estimates and methodologies presented in the EPA cost analysis for the 2008 Standards of Performance for Petroleum Refineries.[50] Staff also applied additional adjustments to these methodologies to reflect temporal and geographic differences and changes in market conditions. These adjustments and sources are described in Section V.A.1.

Capital costs for electrostatic precipitator improvements were estimated to be $30 million at Chevron Products Richmond and $40 million at PBF Martinez Refinery and are included in the total capital cost estimates in Table 7. Staff also estimated total annual costs, which includes amortized capital costs, tax, insurance, general and administrative (G&A) costs, and operating and maintenance (O&M) costs. Amortized capital cost is calculated assuming a project lifetime of 20 years at six percent interest. Operating and maintenance costs were estimated based on the EPA cost estimating methodologies and assumptions described previously. Other annual costs were estimated as a percentage of capital cost, with tax costs of one percent, insurance costs of one percent, and general and administrative costs of two percent. The total annual costs for the

[49] United States Environmental Protection Agency (EPA), 2018a. EPA Air Pollution Control Cost Manual. https://www.epa.gov/economic-and-cost-analysis-air-pollution-regulations/cost-reports-and-guidance-air-pollution. Updated May 23, 2018.
[50] EPA, 2008. Regulatory Impact Analysis for the Petroleum Refineries NSPS (New Source Performance Standards). EPA-452/R-08-002. April.

electrostatic precipitator improvements, including amortized capital and annual operating costs, were estimated to be $4.4 million per year at Chevron Products Richmond and $5.9 million per year at PBF Martinez Refinery. These figures are included in the total annual cost estimates shown in Table 7.

Staff also reviewed available cost information reported for electrostatic precipitator improvements and expansions at other facilities. Staff recognizes that costs of specific electrostatic precipitator projects may vary based on a number of factors, including the age, performance, and capacity of existing electrostatic precipitator systems; specific system designs and technologies; and other site-specific constraints. South Coast Air Quality Management District (South Coast AQMD) staff reported on costs of electrostatic precipitator projects at refineries in their jurisdiction following the adoption of South Coast AQMD Rule 1105.1 in 2003.[51] These costs ranged widely, with four refineries reporting total capital costs ranging from $23 million to $121 million, while one refinery reported total capital costs of $340 million. South Coast AQMD staff noted that these costs were higher than previously estimated costs, and some of the factors potentially leading to these discrepancies include the hyperinflation of construction equipment and labor in 2008, compressed construction schedules caused by the Western States Petroleum Association (WSPA) litigation of the rule, and a sharp increase in steel pricing. In addition, South Coast AQMD staff noted that some of the facilities with much higher costs added extraordinary capacity to their existing electrostatic precipitator systems and elected to upgrade a number of other systems at their site in addition to the electrostatic precipitators.

Air District staff also solicited cost estimate information from the potentially affected refineries. Chevron Products Richmond estimated that additional electrostatic precipitator installations at the refinery would result in capital costs of approximately $100 million. PBF Martinez Refinery estimated that additional electrostatic precipitator installations at the refinery would result in capital costs of approximately $480 million.

b) Cost Estimates for Improved Feed Hydrotreatment and Sulfur Dioxide-Reducing Additives

Staff reviewed information on capital costs for improvements and revamps of fluidized catalytic cracking unit feed hydrotreating systems. Costs for these types of improvement projects may vary based on a number of factors, including the existing equipment train, the specific improvements made, and other site-specific constraints. An industry case study estimated that a hydrotreater revamp project, including the construction of a new product fractionator, would cost $30 million.[52] Other literature also presents capital cost estimate tools for new hydrotreatment systems.[53] Staff also solicited information from PBF Martinez Refinery on potential costs for hydrotreatment improvement projects.

Based on the review of available cost data and tools and stakeholder input, capital costs for hydrotreatment improvements at PBF Martinez Refinery were estimated to be $40 million, which is included in the total capital cost estimates shown in Table 7. Staff also estimated total annual costs, which includes amortized capital costs, tax, insurance, general and administrative (G&A) costs, and operating and maintenance (O&M) costs. Amortized capital cost is calculated assuming a project lifetime of 20 years at six percent interest. Annual costs were estimated as a

[51] South Coast AQMD, 2010. Final Staff Report SOx RECLAIM, Part 1: BARCT Assessment & RTC Reductions Analysis. November.
[52] Schwalje, David; Larry Wisdom; and Mike Craig (Axens North America), 2016. Revamp cat feed hydrotreaters for flexible yields. EPTQ (Petroleum Technology Quarterly), Revamps 2016.
[53] Gary, James H.; Glenn Handwerk; and Mark Kaiser, 2007. Petroleum Refining Technology and Economics, Fifth Ed.

percentage of capital cost, with tax costs of one percent, insurance costs of one percent, general and administrative costs of two percent, and operating and maintenance costs of five percent. The total annual costs for the hydrotreatment improvements at PBF Martinez Refinery, including amortized capital and annual operating costs, were estimated to be $7.1 million per year. In addition, staff reviewed available cost data for the use of optimized and improved sulfur dioxide-reducing additives from EPA, South Coast AQMD, and industry literature.[54,55,56,57] Based on this review, staff estimated that optimization and improvement of sulfur dioxide-reducing additives would result in an additional annual cost of $1.5 million. These figures are included in the total annual cost estimates shown in Table 7.

C. Socioeconomic Impacts

The Air District is required to assess and consider potential socioeconomic impacts when adopting or amending regulations.[58] Air District staff contracted with an independent consultant, Applied Development Economics (ADE), to develop estimates of potential socioeconomic impacts for the proposed amendments to Rule 6-5 and the less stringent control option identified in Section V.B. The analysis and findings are summarized in this section, and the full report of the socioeconomic impact analysis is available in Appendix C.

When analyzing the potential socioeconomic impacts of proposed new rules and amendments, ADE attempts to work closely within the parameters of accepted methodologies discussed in a California Air Resources Board report on the assessment of economic impacts;[59] the methodologies described in this report have also been incorporated by the California Air Resources Board in its own assessment of socioeconomic impacts of regulations adopted by the California Air Resources Board. One methodology relates to determining a level above which a rule and its associated costs is deemed to have significant impacts. When analyzing the degree to which the impacts are significant or insignificant, the California Air Resources Board employs a threshold of significance that ADE follows. The report states that the California Air Resources Board's use of a ten percent change in return on equity as a threshold for finding no significant adverse impact on competitiveness or jobs seems reasonable or even conservative.

Applied Development Economics estimated sales generated by impacted industries, as well as net profits for each affected industry. To estimate net after tax profit ratios for potentially affected sources, ADE calculated ratios of profit per dollar of revenue for affected industries. The result of the socioeconomic analysis shows what proportion of profits the compliance costs represent. Based on assumed thresholds of significance, these analyses provide estimates of which impacts are potentially significant or insignificant, and whether the affected sources may reduce jobs as a means of recouping the cost of rule compliance or as a result of reducing business operations. In some instances, particularly where consumers are the ultimately end-users of goods and services

[54] EPA, 2008. Regulatory Impact Analysis for the Petroleum Refineries NSPS (New Source Performance Standards). EPA-452/R-08-002. April.
[55] South Coast AQMD, 2003. Final Staff Report for Proposed Rule 1105.1. September.
[56] South Coast AQMD, 2010. Final Staff Report SOx RECLAIM, Part 1: BARCT Assessment & RTC Reductions Analysis. November.
[57] Evans, Martin (Intercat/Johnson Matthey), 2008. Evaluating FCC flue gas emission-control technologies. Digital Refining, 2008 Q1.
[58] California Health and Safety Code, Section 40728.5.
[59] Berck, Peter, 1995. "Development of a Methodology to Assess the Economic Impact Required by SB513/AB969." Department of Agricultural and Resources Economics, University of California. California Air Resources Board Contract No. 93-314. August.

provided by the affected sources, ADE also analyzed whether costs could be passed to consumers in the region.

These analyses rely heavily on the most current data available from a variety of sources, including corporate reports filed with the Securities Exchange Commission (SEC), data from the US Census County Business Patterns and Census of Manufactures, the US Internal Revenue Service, and reports published by the California Energy Commission (CEC) that track gasoline prices and cost components as well as refinery production levels. ADE also utilized employment data from the California Employment Development Department – Labor Market Information Division (EDD LMID).

1. Estimates of Revenues and Net Profits of Potentially Affected Facilities

The crude oil capacity of each potentially affected refinery reported by the California Energy Commission (CEC) is shown in Table 8. ADE also estimated the effective throughput of each refinery (shown in Table 8) based on average utilization rates as provided in the US Census of Manufactures and the average yield of refined product from the California Energy Commission. Table 8 also shows the estimated revenue calculated using a wholesale value of gasoline at $121.04 per barrel, which is based on California Energy Commission estimates for 2019. The net profits were estimated for each refinery as described below.

In its 2019 annual report, Chevron reported $1.559 billion in earnings from its US downstream refining operations and sales of 1.25 million barrels of gasoline and other refined products. ADE estimated that Chevron earned $1,247 per barrel per day (BPD) of refined product. Based on capacity and utilization data from the California Energy Commission and the US Census of Manufacturers, ADE estimated an output of approximately 226,820 barrels of refined product at Chevron Products Richmond, resulting in an estimated annual net income of $282.8 million at the refinery. This information is summarized in Table 8.

PBF Energy completed the purchase of the Martinez refinery from Shell in February 2020, so there is no 2019 operating or financial data for the refinery under PBF ownership. Consequently, the operating performance of the Martinez refinery is estimated based on Shell's annual report for 2019. Shell reported downstream refinery net earnings of $6.7 billion for all its refining operations and indicates that 19 percent of its refined products sales occurred from US operations, resulting in a prorated net earnings of $1.27 billion for US refineries. Shell reported that total US refining capacity was 1,117,000 barrels per day (BPD), which yields a return of $1,136 per BPD capacity, slightly below the comparable figure for Chevron. Based on these factors, it was estimated that the net income from the Martinez refinery was $177.7 million. The 2019 net income represents 2.8 percent of estimated sales revenue.

Marathon does not report net income per barrel in the same way as Chevron and Shell, but its 2019 Annual Report indicates that for all its refineries, sales revenue totaled $106.7 billion and income from operations was $2.367 billion. The net income ratio from these figures is 2.2 percent, which has been applied to the sales estimate in Table 8 to derive the net income figure for that refinery.

Table 8 – Estimates of Revenues and Net Profits at Potentially Affected Facilities

Facility	Barrels Per Day Capacity	Effective Barrels Per Day	Estimated Revenues	Estimated Net Profits
Chevron Products Richmond	245,271	226,820	$10.0 billion	$282.8 million
Marathon Martinez Refinery[a]	*161,500*	*149,350*	*$6.6 billion*	*$146.5 million*
PBF Martinez Refinery	156,400	144,600	$6.4 billion	$177.7 million

[a] The Marathon Martinez Refinery announced the idling of the refinery, including the facility's fluidized catalytic cracking unit, in April 2020. Marathon announced in July 2020 that the facility would remain indefinitely idled with no plans to restart.

2. Estimates of Potential Socioeconomic Impacts Associated with the Proposed Amendments

As described in Section V.A, staff anticipates that Chevron Products Richmond, Marathon Martinez Refinery, and PBF Martinez Refinery would be required to implement additional controls to comply with the proposed amendments. Table 9 shows the estimated proportion of profits the total annual compliance costs represent. As shown, the estimated compliance costs at all three facilities exceed the assumed threshold of ten percent of return on equity that would indicate the potential to create significant adverse socioeconomic impacts.

Table 9 – Estimates of Potential Socioeconomic Impacts for Proposed Amendments

Facility	Estimated Total Annual Compliance Cost	Estimated Annual Net Income	Estimated Portion of Net Profits
Chevron Products Richmond	$39 MM	$282.8 MM	13.7%
Marathon Martinez Refinery[a]	*$38 MM*	*$146.5 MM*	*25.8%*
PBF Martinez Refinery	$40 MM	$177.7 MM	22.3%

[a] The Marathon Martinez Refinery announced the idling of the refinery, including the facility's fluidized catalytic cracking unit, in April 2020. Marathon announced in July 2020 that the facility would remain indefinitely idled with no plans to restart.

Under the proposed amendments, the affected refineries would be expected to attempt to reduce other costs or increase revenues to restore the cost impact below ten percent of net income. The annual amounts necessary to achieve this result are approximately $11 million per year at Chevron Products Richmond, $23 million per year at Marathon Martinez Refinery, and $22 million per year at PBF Martinez Refinery. There are several ways the companies could consider making these adjustments, although it is not clear if any are feasible at these facilities. If the companies reduced labor costs in these amounts, it would be equivalent to reducing employment by 62 jobs at Chevron Products Richmond, 136 jobs at Marathon Martinez Refinery, and 128 jobs at PBF Martinez Refinery. Note that the equivalent reductions at Marathon Martinez Refinery and PBF Martinez Refinery would amount to an estimated labor reduction of approximately 19 to 20 percent, and it is not clear whether the facilities could operate at capacity with this level of staff reductions.

On the revenue side, the highest estimated cost impacts are at Marathon Martinez Refinery and PBF Martinez Refinery. At PBF Martinez Refinery, these impacts would amount to approximately 0.62 percent of estimated annual revenue at the facility. Translated to the wholesale price for gasoline, this equals about $0.75 per barrel or $0.02 per gallon. While individual refineries may be limited in their ability to increase prices unilaterally, particularly during periods of falling demand, the price increases required to reduce the significance of the emission reduction costs are well within the level of gas price fluctuations that normally occur due to changes in demand and supply factors annually.

Therefore, while the socioeconomic impacts are potentially significant for the affected facilities, it is likely they can be mitigated to less than significant levels. In addition, these impacts and adjustments may have other impacts throughout the region. For example, an increase in gasoline prices could have multiplier effects in the regional economy as consumers shift spending from other sectors to increased transportation costs, but jobs and income created through the installation and construction of the control technologies could offset impacts of the increased gas prices.

3. Estimates of Potential Socioeconomic Impacts Associated with Less Stringent Control Option

As described in Section V.B, staff anticipates that Chevron Products Richmond and PBF Martinez Refinery would be required to modify or install additional controls to comply with the less stringent control option identified. Table 10 shows the estimated proportion of profits the total annual compliance costs represent. As shown, the estimated compliance costs under the less stringent control option do not exceed the assumed threshold of ten percent of return on equity that would indicate the potential to create significant adverse socioeconomic impacts.

Table 10 – Estimates of Potential Socioeconomic Impacts for Less Stringent Control Option

Facility	Estimated Total Annual Compliance Cost	Estimated Annual Net Income	Estimated Portion of Net Profits
Chevron Products Richmond	$4.4 MM	$282.8 MM	1.6%
Marathon Martinez Refinery[a]	–	*$146.5 MM*	–
PBF Martinez Refinery	$14 MM	$177.7 MM	8.1%

[a] The Marathon Martinez Refinery announced the idling of the refinery, including the facility's fluidized catalytic cracking unit, in April 2020. Marathon announced in July 2020 that the facility would remain indefinitely idled with no plans to restart.

D. *Exposure and Health Equity Assessment*

Reductions in particulate matter emissions would lead to reductions in ambient concentrations, which result in improvements to the health of exposed populations. Staff used an atmospheric model (see Appendices A.4 and A.5 for further information) to estimate the contribution of baseline emissions of $PM_{2.5}$ to ambient concentrations, and then to estimate changes that would result from expected reductions in emissions (Table 11) as well as changes in stack configurations. Staff conducted this modeling for the Chevron Richmond Products and PBF Martinez Refinery facilities, and evaluated a scenario for the proposed amendments and a scenario for the less stringent control option identified. Throughout this section and Appendices A.1 through A.5, the scenario for the less stringent control option is referred to as "Control Scenario A", and the scenario for the more stringent proposed amendments is referred to as "Control Scenario B".

1. Study Area and Modeled Contributions to Ambient $PM_{2.5}$

Figure 3, below, shows the estimated contributions of baseline emissions from modeled sources to ambient $PM_{2.5}$. The baseline emissions used for the modeling include contributions representative of 2018, the most recent year that emissions have been checked and finalized by

Air District staff, but with changes to reflect significant reductions in non-FCCU sources at Chevron Products Richmond since 2018 (due to the Chevron Refinery Modernization Project[60]).

The outermost contour represents a contribution of +0.1 microgram per cubic meter (μg/m^3), which as an order-of-magnitude is approximately 1 percent of the total ambient concentration within the general area. Note that 0.1 μg/m^3 is not a *de minimis* value, as there are potentially significant real-world impacts beyond this contour. However, the +0.1 μg/m^3 contour was selected by staff to define a "study area" to assess the exposure and health of a more localized population.

Figure 4 shows the same outermost contour (i.e., study area) from Figure 3, and overlays it with information on the residential population. The modeled population is a forecast of the 2020 population based on 2010 Census data (see Appendices A.1, A.2, and A.3 for further information) and consists of approximately one million residents, with a racial/ethnic composition similar to that of the Bay Area as a whole (Appendix A.1): 42 percent white; 26 percent Hispanic/Latino; 21 percent Asian/Pacific Islander; 11 percent African-American/Black, and 0.3 percent Native American/Alaska Native.

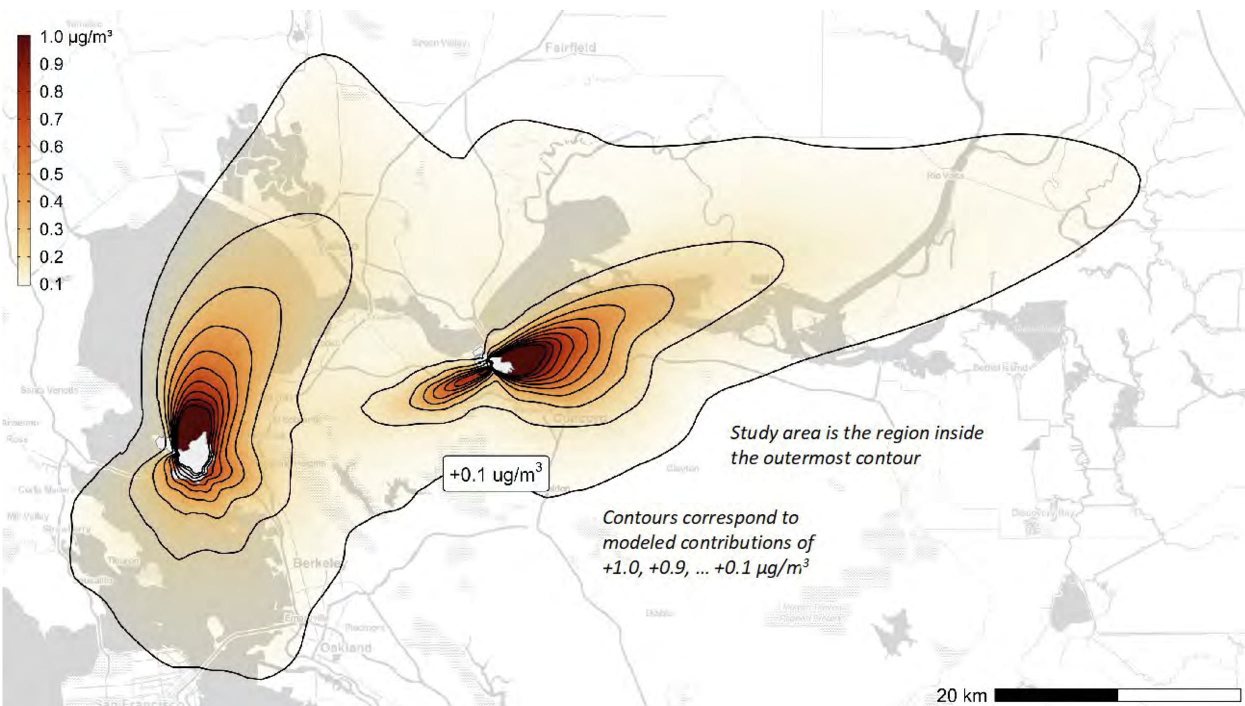

Figure 3 – Contributions of modeled baseline emissions to ambient $PM_{2.5}$

The outermost contour represents a contribution of +0.1 μg/m^3, which is approximately 1 percent of ambient $PM_{2.5}$ within the vicinity. Contributions less than +0.1 μg/m^3 (i.e., beyond the study area) are not shown.

[60] City of Richmond, 2015. Chevron Refinery Modernization Project Environmental Impact Report, Consolidated Version Volumes 1 and 2, SCH No. 2011062042. October.

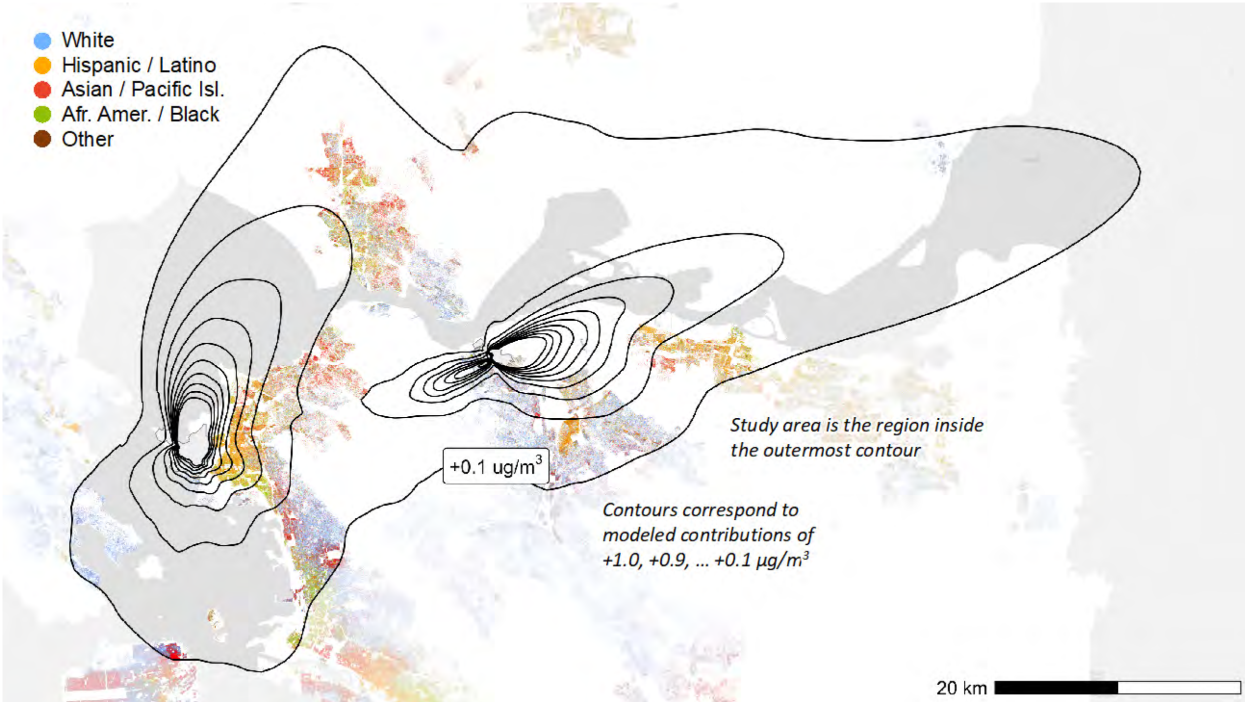

Figure 4 – Residential population

Each dot corresponds to one resident; colors correspond to US Census race/ethnicity categories. Approximately one million people reside in the study area.

2. Equity Assessment: Distributions of Modeled Exposures

Combining the data from Figures 3 and 4 — that is, weighting $PM_{2.5}$ contributions by residential population — provides estimates of attributable exposure (see Appendix A.1 for technical details). Figures 5a through 5c, below, summarize these exposures according to race/ethnicity across all modeled scenarios. As shown, the exposures are not distributed equally, and inequities persist across all modeled scenarios.

Figure 5a shows the estimates of *total population exposure*, which depends both on the intensity of the exposure and on the number of people exposed. On the y-axis of Figure 5a, thirty thousand (30,000) "exposure units" (person-µg/m^3) are equivalent to a city of 100,000 persons exposed to 0.3 µg/m^3, and/or a population of one million persons exposed to 0.03 µg/m^3. A notable finding is that the total population exposure burden attributable to Chevron emissions (top row) for Hispanic and Latino residents (orange) under the baseline scenario ("Base") is approximately 45,000 person-µg/m^3. This is larger than any other baseline estimate in the top row, and is due to the close proximity of Chevron Products Richmond to neighborhoods that are both densely populated and comprised largely of Hispanic/Latino residents (Figure 4).

In addition to the total population exposure, staff estimated the *exposure intensity* for an "average" or randomly selected resident within a particular racial/ethnic category (or "per capita" exposure). In Figure 5b, the total population exposures from Figure 5a have been divided by the number of persons affected to calculate this "per capita" exposure. These per capita exposure estimates show a number of differences compared to the total population exposure estimates. As an example, again considering Chevron emissions alone (top row), Figure 5a shows that the total population exposure for white residents (blue bars) is higher than for African-American/Black residents (green bars), but Figure 5b shows that the per capita exposure for African-

American/Black residents (green bars) is now higher than for white residents (blue bars). This is because, although white residents outnumber African-American/Black residents within the study area, the exposures of African-American/Black residents to $PM_{2.5}$ from Chevron are, on average, nearly twice as high as those of white residents.

Figure 5c shows the combined per capita impacts from both facilities. This figure shows that Hispanic/Latino and African American/Black residents are exposed to more $PM_{2.5}$ in all modeled scenarios per capita. Emissions from modeled sources other than fluidized catalytic cracking units (represented by the lighter portions of the bars in Figures 5a through 5c) drive these disparities and remain significant across all modeled scenarios. The combined impact is mostly attributable to modeled contributions from Chevron emissions, which are responsible for approximately twice as much modeled population exposure as those from PBF emissions (Figure 5a).

Figure 5a – Modeled estimates of total population exposure (residential impact) within the study area

Within each of the eight panels, there are three bars. The leftmost bar corresponds to the baseline scenario. The middle and rightmost bars correspond to scenarios where emissions from the FCCU have been reduced (Scenario A = Less Stringent Control Option; Scenario B = Proposed Amendments). Bar heights correspond to total impacts from all modeled sources; the darker portions of the bars correspond to the shares of those impacts that are specifically attributed to FCCU emissions.

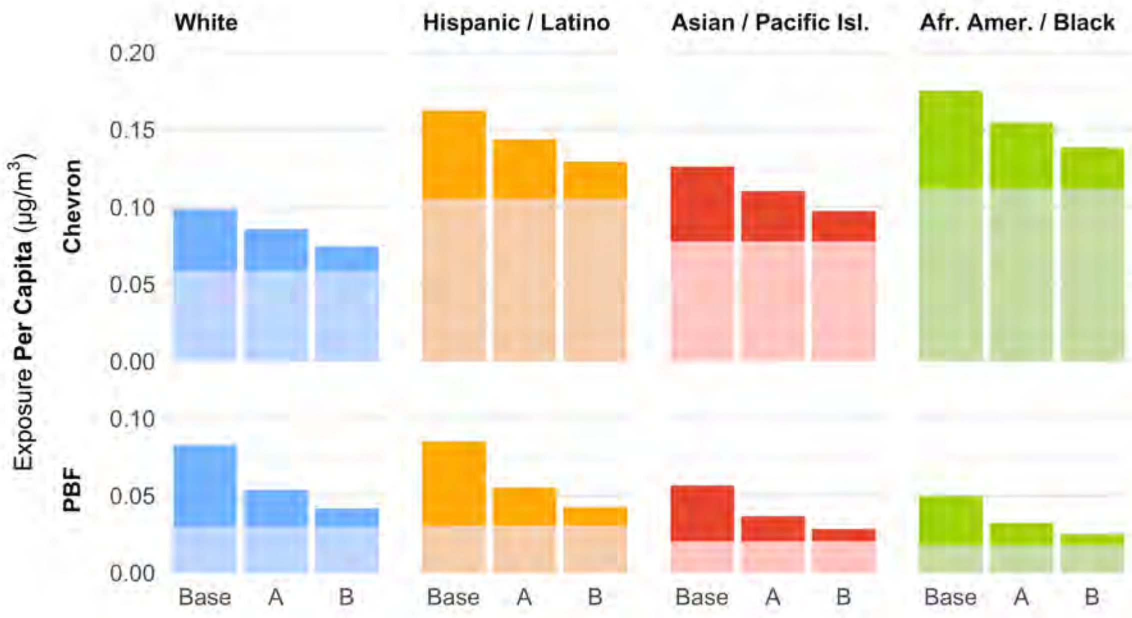

Figure 5b – Modeled estimates of total population exposure (residential impact) within the study area normalized by population

Same as Figure 5a, except that the y-axes have been normalized by population, yielding bar heights that correspond to average (that is, "per capita") impacts. Scenario A = Less Stringent Control Option; Scenario B = Proposed Amendments.

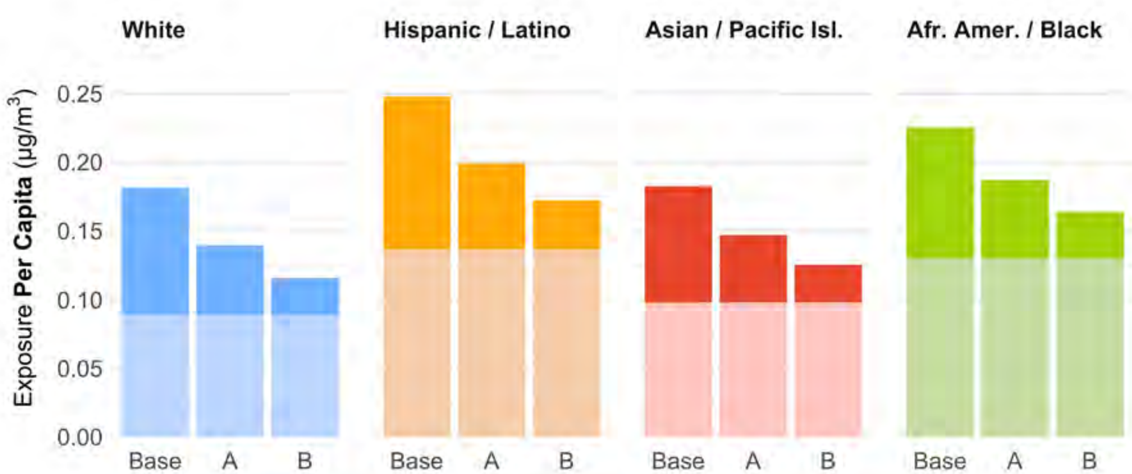

Figure 5c – Combined modeled estimates of total population exposure (residential impact) within the study area normalized by population

Same as Figure 5b, except that impacts from both facilities have been combined. Scenario A = Less Stringent Control Option; Scenario B = Proposed Amendments.

E. *Preliminary Estimates and Valuations of Health Impacts*

Staff selected a representative set of health endpoints to assess in light of the modeled exposures described in the previous section. Staff used a methodology and software platform (BenMAP) developed by the US Environmental Protection Agency to calculate:

- baseline impacts of modeled $PM_{2.5}$ emissions on selected health endpoints;
- benefits associated with modeled reductions; and
- conventional (EPA-approved) valuations of both the baseline impacts and the reductions.

For details of the methodology, see Appendices A.2 and A.3 and EPA's BenMAP.[61]

1. Estimated Health Impacts, Benefits from Reductions, and Valuations

Table 11 provides a summary that is scoped to Chevron Products Richmond, and Table 12 provides a summary that is scoped to PBF Martinez Refinery. Each row corresponds to a single health impact from among those that were estimated. For health impacts where valuation ranges are presented, the ranges indicate the minimum and maximum estimates derived from multiple studies of the same health endpoint (e.g., premature mortality). The first two columns report the annual impacts, and conventional (EPA-approved) valuations of those impacts, attributed to modeled baseline emissions. The next two columns present reductions—which apply both to those impacts and to their valuations—modeled under Control Scenario A (Less Stringent Control Option) and B (Proposed Amendments). The final row is the summation of the last two columns, in 2015 US Dollars. In all cases, mortality comprises the vast majority (over 90 percent) of the total valuation. Limitations are described below; for details, see Appendices A.2 and A.3.

[61] EPA, 2018c. "Environmental Benefits Mapping and Analysis Program Community Edition (BenMAP-CE) Users' Manual, V1.4.8." Office of Air Quality Planning; Standards (OAQPS). Research Triangle Park, NC, July.

Table 11 – Estimated Annual Baseline Health Impacts, Reductions, and Valuations (Annual, All Modeled Sources at Chevron Products Richmond Alone)

Under Baseline Conditions			Potential Benefits	
Health Impact		**Valuation[1]**	**Scenario A (Less Stringent Control Option)**	**Scenario B (Proposed Amendments)**
Cardiovascular	0.5–4.3 heart attacks	$63k–600k	-13%	-22%
	1.0 hospital admissions	$47k	-13%	-22%
Restricted Activity	4,800 days	$360k	-12%	-21%
Lost Work	820 days	$190k	-12%	-21%
Asthma	200 exacerbations[3]	$12k	-12%	-21%
	4 emergency room visits	$2k	-12%	-21%
	0.1 hospital admissions	$1k	-12%	-20%
Respiratory Illness[2]	140 upper tract[3]	$5k	-12%	-20%
	100 lower tract[3]	$2k	-12%	-20%
	8 bronchitis[3]	$4k	-12%	-20%
	0.2 chronic lung disease	$5k	-12%	-21%
Mortality	5.1–11.6 deaths[4]	$52.5 MM to $118 MM	-13%	-23%
			$6.8 MM to $15.2 MM/yr	**$12.2 MM to $27.4 MM/yr**

[1] Conventional EPA valuations, in 2015 US dollars
[2] Other than asthma
[3] Subset of pediatric (≤18 years)
[4] Including infant mortality

Table 12 – Estimated Annual Baseline Health Impacts, Reductions, and Valuations (Annual, All Modeled Sources at PBF Martinez Refinery Alone)

Under Baseline Conditions			Potential Benefits	
Health Impact		**Valuation[1]**	**Scenario A (Less Stringent Control Option)**	**Scenario B (Proposed Amendments)**
Cardiovascular	0.3–2.4 heart attacks	$37k–350k	-35%	-50%
	0.6 hospital admissions	$26k	-35%	-50%
Restricted Activity	2,700 days	$200k	-35%	-50%
Lost Work	460 days	$100k	-35%	-50%
Asthma	110 exacerbations[3]	$7k	-35%	-50%
	2 emergency room visits	$1k	-35%	-50%
	<0.1 hospital admissions	$1k	-35%	-50%
Respiratory Illness[2]	80 upper tract[3]	$3k	-35%	-50%
	50 lower tract[3]	$1k	-35%	-50%
	4 bronchitis[3]	$2k	-35%	-50%
	0.1 chronic lung disease	$3k	-35%	-50%
Mortality	2.8–6.3 deaths[4]	$28.8 MM to $64.9 MM	-35%	-50%
			$10.1 MM to $22.7 MM/yr	**$14.4 MM to $32.4 MM/yr**

[1] Conventional EPA valuations, in 2015 US dollars
[2] Other than asthma
[3] Subset of pediatric (≤18 years)
[4] Including infant mortality

2. Summary of Estimated Annual Reductions, Benefits, and Costs

Table 13 reproduces the bottom-line valuations from Table 11 and Table 12 alongside the estimates of emissions reductions and associated costs that were reported in previous sections.

Table 13 – Modeled Reductions, Valuations of Benefits, and Costs (Annual, Chevron Products Richmond and PBF Martinez Refinery)

Facility	Scenario	Emission Reductions*	Valuation of Assessed Benefits†,‡	Estimated Annual Costs
Chevron Products Richmond	Less Stringent Control Option (A)	80 ton/yr	\$6.8 MM to \$15 MM/yr	\$4.4 MM/yr
	Proposed Amendments (B)	160 ton/yr	\$12 MM to \$27 MM/yr	\$39 MM/yr
PBF Martinez Refinery	Less Stringent Control Option (A)	170 ton/yr	\$10 MM to \$23 MM/yr	\$14 MM/yr
	Proposed Amendments (B)	240 ton/yr	\$14 MM to \$32 MM/yr	\$40 MM/yr

** PM_{10} from FCCU. Modeled $PM_{2.5}$ / PM_{10} ratio for the Chevron FCCU is approximately 95%. Modeled $PM_{2.5}$ / PM_{10} ratio for the PBF Martinez FCCU is approximately 97%.*

† Based on EPA-approved valuations of the health endpoints that were assessed for the 1 million people in the study area.

‡ Valuations are in 2015 US Dollars, calculated using the EPA BenMAP system.

3. Limitations and Comparability

Tables 11 through 13 show estimates of potential benefits and invite comparison with estimated costs. In this context, several important limitations should be noted.

First, the set of reported benefits is limited in the scope of the health endpoints included. It does not include, for example, benefits to reproductive health or neurological health. Including more health endpoints would increase the estimated benefits. Using BenMAP to evaluate a particular health endpoint requires at least one sufficiently reliable "concentration-response" function (linking $PM_{2.5}$ to a measurable outcome) to be available, and at least one valuation function (linking that outcome to dollars) to be available. See Appendix A.2 for details.

Second, reported benefits are scoped to the population included in the defined study area. (See Section V.D.1.) The size of the study area, as we have defined it, is linked to the baseline emission estimates, which means that it inherits uncertainties in those estimates. The baseline emissions represent contributions in 2018 from two of the five Bay Area refineries (with adjustments described in Section V.D.1). If the study area were adjusted to match a +0.1 μg/m^3 contour estimated from a different set of baseline emissions (including non-FCCU emissions), then it could grow or shrink. For example, the study area would grow if baseline emissions from the Valero Benicia Refinery, which is also subject to this proposed rule, were accounted for. This would increase the estimated total benefits since the covered study population would increase.

Third, there are considerable uncertainties embedded in different parts of the underlying calculations, including: (a) estimated emissions; (b) modeled concentrations; (c) population distributions; and (d) concentration-response functions. These uncertainties were not carried forward in calculating the ranges reported in Tables 11 and 12. Therefore, the true benefits could be much larger, or much smaller, than those ranges suggest.

Finally, the valuation of avoided mortality, which comprises the majority (over 90 percent) of the total reported valuation, is based on willingness-to-pay (WTP). As documented by the EPA,[62] WTP is fundamentally subjective:

The WTP [willingness-to-pay] for a given benefit is likely to vary from one individual to another. In theory, the total social value associated with the decrease in risk of a given health problem resulting from a given reduction in pollution concentrations is generally taken to be the sum of everyone's WTP for the benefits they receive.

F. District Impacts

Staff anticipates that the proposed amendments may require additional staff time and resources in a number of areas. Air District Engineering resources may be required in the review, processing, and evaluation of permit applications for installations of new air pollution control equipment and abatement devices. Air District Compliance and Enforcement resources may be required for review and documentation of any rule requirements that are not met and may also be required for assistance in the evaluation of permit applications for any air pollution control equipment installations. Air District Meteorology and Measurement resources would be needed to review monitoring and testing reports submitted, and to verify compliance with testing and monitoring procedures. Additional resources would be required to coordinate and conduct testing at the affected facilities. This may involve the procurement of additional equipment, instrumentation, and testing infrastructure, and ongoing costs for additional staffing to conduct testing.

VI. REGULATORY IMPACTS

A regulatory impact analysis is required by California Health and Safety Code Section 40727.2 to compare the proposal to other Air District, State and federal rules addressing the same sources. The following Table 14 provides this regulatory impact analysis.

[62] EPA, 2018c. "Environmental Benefits Mapping and Analysis Program Community Edition (BenMAP-CE) Users' Manual, V1.4.8." Office of Air Quality Planning; Standards (OAQPS). Research Triangle Park, NC, July.

Table 14 – H&SC Section 40727.2 Regulatory Analysis: Proposed Amendments to Rule 6-5

Section	Description (paraphrased)	Comparable State or Air District Provision	Comparable Federal Provision	Discussion
101	Description	N/A	N/A	No applicable requirements.
111	Limited Exemption, Wet Scrubber	N/A	N/A	Provides exemption from ammonia limit if source is abated by a wet gas scrubber that meets BACT requirements.
112	Limited Exemption, Startup or Shutdown	SCAQMD Rule 1105.1	N/A	Provides limited exemption during shutdown and startup periods, consistent with SCAQMD Rule 1105.1.
113	Deleted, Limited Exemption, Installation of Wet Scrubber	N/A	N/A	No applicable requirements.
114	Limited Exemption, FCCU without Nitrogen-Based Additives	N/A	N/A	Provides exemption from ammonia limit for sources not using ammonia additives.
115	Limited Exemption, Ammonia Optimization	N/A	N/A	Proposed amendments would provide an end date for this limited exemption.
200	Definitions			
212	Total PM_{10}	BAAQMD Regulation 6	N/A	Definition is consistent with BAAQMD Regulation 6.
213	Total $PM_{2.5}$	BAAQMD Regulation 6	N/A	Definition is consistent with BAAQMD Regulation 6.
300	Standards			
301.1	Ammonia slip emission concentration limit	SCAQMD Rule 1105.1	N/A	Proposed ammonia slip limit is consistent with SCAQMD Rule 1105.1 limit.
301.2	Sulfur dioxide emission concentration limits	BAAQMD Rule 9-1 SCAQMD Rule 1105	40 CFR 60 Subpart J (NSPS) 40 CFR 60 Subpart Ja (NSPS)	Proposed sulfur dioxide limits are more stringent than BAAQMD Rule 9-1, SCAQMD Rule 1105, and NSPS Subpart J limits for FCCUs. Proposed sulfur dioxide limits are consistent with NSPS Subpart Ja limits for FCCUs constructed or modified after May 14, 2007.
301.3	Total PM_{10} emission limit	SCAQMD Rule 1105.1	40 CFR 60 Subpart J (NSPS) 40 CFR 60 Subpart Ja (NSPS) 40 CFR 63 Subpart UUU (NESHAP)	Proposed PM limit applies to total PM_{10} emissions. SCAQMD Rule 1105.1 and federal PM emission limits only apply to filterable PM.
400	Administrative Requirements			

Section	Description (paraphrased)	Comparable State or Air District Provision	Comparable Federal Provision	Discussion
403	Ammonia Optimization	N/A	N/A	Administrative requirement.
404	Reporting Requirements	N/A	N/A	Administrative requirement.
500	Monitoring and Records			
502	Sulfur Dioxide Monitoring	BAAQMD Rule 9-1	40 CFR 60 Subpart J (NSPS) 40 CFR 60 Subpart Ja (NSPS)	Proposed sulfur dioxide monitoring requirements are consistent with BAAQMD Rule 9-1 and NSPS Subparts J and Ja requirements.
503	Total PM_{10} and Total $PM_{2.5}$ Monitoring	SCAQMD Rule 1105.1	40 CFR 60 Subpart J (NSPS) 40 CFR 60 Subpart Ja (NSPS) 40 CFR 63 Subpart UUU (NESHAP)	Proposed amendments require monitoring of total PM_{10} and total $PM_{2.5}$ through quarterly testing or other approved methods. NSPS Subparts J and Ja require monitoring for filterable PM only. SCAQMD Rule 1105.1 requires testing for filterable and condensable PM on an annual basis.
504	Records	N/A	N/A	Administrative requirement.
600	Manual of Procedures			
601	Compliance Determination	N/A	N/A	Administrative requirement.
602	Determination of Ammonia and Oxygen	SCAQMD Rule 1105.1	N/A	Proposed amendments specify and clarify performance requirements for continuous or parametric ammonia monitoring. SCAQMD Rule 1105.1 requires annual source test for ammonia emissions.
603	Determination of Sulfur Dioxide	BAAQMD Rule 9-1	40 CFR 60 Subpart J (NSPS) 40 CFR 60 Subpart Ja (NSPS)	Proposed amendments for the determination of sulfur dioxide are consistent with BAAQMD Rule 9-1 and NSPS Subpart J and Ja requirements.
604	Determination of Total PM_{10}	SCAQMD Rule 1105.1	40 CFR 51, Appendix M	Proposed amendments for the determination of total PM_{10} are consistent with Method 201A and Method 202 of Appendix M of 40 CFR 51. SCAQMD Rule 1105.1 requires the use of SCAQMD Source Test Method 5.2.
605	Determination of Total $PM_{2.5}$	N/A	40 CFR 51, Appendix M	Proposed amendments for the determination of total $PM_{2.5}$ are consistent with Method 201A and Method 202 of Appendix M of 40 CFR 51.

VII. ENVIRONMENTAL IMPACTS

The California Environmental Quality Act (CEQA), Public Resources Code Section 21000 et seq., require a government agency that undertakes or approves a discretionary project to consider the potential impacts of that project on all environmental media. Potential environmental impacts related to projects under the AB 617 Expedited Best Available Retrofit Control Technology (BARCT) Implementation Schedule, including amendments to Rule 6-5, were previously analyzed in an Environmental Impact Report (EIR) certified by the Air District Board of Directors on December 19, 2018 (State Clearing House Number: 2018082003). The EIR found that implementation of the projects under the AB 617 Expedited BARCT Implementation Schedule would result in significant impacts. The EIR concluded that air quality impacts associated with the construction of air pollution control equipment would be potentially significant after mitigation and cumulatively considerable. Water demand impacts from the operation of air pollution control equipment were found to be potentially significant after mitigation and cumulatively considerable. The Air District incorporates the EIR into the record, and the EIR is attached to this Staff Report as Appendix D.

The proposed amendments to Rule 6-5 do not present substantial changes in the project or circumstances or new information that would require a new analysis. Staff anticipates the proposed amendments to Rule 6-5 would require the installation of up to three wet gas scrubbers at refinery FCCUs, as was anticipated in the EIR. Air quality impacts associated with the construction of this air pollution control equipment and water demand impacts from the operation of this control equipment are not anticipated to be substantially different than the impacts described in the EIR. No subsequent or supplemental EIR is required as there have not been substantial changes in the proposed project that would require major revisions to the EIR, there have not be substantial changes with respect to the circumstances under which the project is being undertaken that would require major revisions to the EIR, and there is no new information available that would change the analysis in the EIR. Therefore, the Air District continues to rely on the EIR pursuant to CEQA section 21166.

VIII. RULE DEVELOPMENT / PUBLIC PARTICIPATION PROCESS

The Air District adopted the AB 617 Expedited Best Available Retrofit Control Technology (BARCT) Implementation Schedule in December 2018. As part of the schedule, staff identified potential efforts to develop amendments to Rule 6-5 that would address particulate matter, including condensable particulate matter components such as ammonia and sulfur dioxide. An update on the implementation of currently adopted refinery rules and rule development efforts on amendments to Rule 6-5 was presented at a Board of Directors Stationary Source Committee meeting in April 2019. In September and October 2019, staff convened meetings of the Air District's Refinery Rules Technical Working Group to engage with stakeholders on technical topics related to the rule development effort for amendments to Rule 6-5. Members of the technical working group, which include representatives from industry, community-based organizations, and regulatory agencies, provided input on control technologies and testing/monitoring methods related to fluidized catalytic cracking units and particulate matter control. Air District staff also conducted site visits to potentially affected refineries to better understand each fluidized catalytic cracking unit operation and site-specific considerations.

The Air District released draft amendments to Rule 6-5 and an Initial Staff Report in May 2020 for public review and comment. Staff presented information on the draft amendments and rule development effort at Air District Stationary Source Committee meetings in June, July, October, and December 2020, including information on other potential control options that staff have further evaluated following the release of the draft amendments. Following the release of the draft amendments in May 2020, staff further evaluated other more stringent control options for these sources. In January 2021, Air District staff released two versions of draft amendments and a workshop report reflecting two alternative control options. Staff conducted a virtual public workshop on the draft amendments on February 4, 2021 and received public comments on the materials through March 1, 2021. The Air District staff presented updates on the workshop, materials, and comments received at an Air District Stationary Source and Climate Impacts Committee meeting in March 2021. In that meeting, a majority of Committee members expressed a preference to proceed with development of the more stringent of the two control options issued for comment in January.

The Air District released the Staff Report and proposed amendments to Rule 6-5 for public review and comment on March 30, 2021. Staff received 47 comment letters from a number of residents, medical professionals, refinery staff, local governments, environmental advocacy groups, affected facilities, and industry associations. Comments were submitted on many topics, including:

- Support for the proposed amendments
- Opposition to the proposed amendments
- Support for other control options
- Compliance costs and cost estimates
- Socioeconomic impacts
- Impacts on fuels markets
- Environmental impacts
- Emissions estimates and test methods
- Air pollution control equipment technical feasibility
- Air quality modeling
- Health impacts modeling
- Health impacts of particulate matter
- Legal and statutory requirements

Air District staff have addressed the submitted comments and prepared a Response to Comments document. At the Public Hearing, the Air District Board of Directors will consider the final proposal and receive public input before taking any action on the proposed amendments to Rule 6-5.

IX. CONCLUSION / RECOMMENDATIONS

Pursuant to the California Health and Safety Code Section 40727, before adopting, amending, or repealing a rule the Board of Directors must make findings of necessity, authority, clarity, consistency, non-duplication and reference. This section addresses each of these findings.

A. Necessity

As stated in California Health and Safety Code Section 40727(b)(1), "'Necessity' means that a need exists for the regulation, or for its amendment or repeal, as demonstrated by the record of the rulemaking authority."

The San Francisco Bay Area does not currently attain all state and national ambient air quality standards for particulate matter, and further reductions of particulate matter emissions are needed for attainment and maintenance of the standards. The proposed amendments to Rule 6-5 would reduce particulate matter emissions from petroleum refinery fluidized catalytic cracking units, which are among the largest individual sources of particulate matter emissions in the Bay Area. The proposed amendments to Rule 6-5 are needed to ensure attainment and maintenance of these ambient air quality standards for particulate matter and to provide clean air and public health benefits.

The proposed amendments to Rule 6-5 were identified in the Air District's AB 617 Expedited Best Available Retrofit Control Technology (BARCT) Implementation Schedule. AB 617 requires that district adopt an expedited schedule for implementation of best available retrofit control technology by the earliest feasible date, and no later than December 31, 2023. The proposed amendments to Rule 6-5 are needed to implement these BARCT requirements consistent with AB 617 and California Health and Safety Code Section 40920.6(c).

B. Authority

The California Health and Safety Code Section 40727(b)(2) states that "'Authority' means that a provision of law or of a state or federal regulation permits or requires the regional agency to adopt, amend, or repeal the regulation."

The Air District has the authority to adopt these rule amendments under Sections 40000, 40001, 40702, and 40725 through 40728.5 of the California Health and Safety Code.

C. Clarity

The California Health and Safety Code Section 40727(b)(3) states that "'Clarity' means that the regulation is written or displayed so that its meaning can be easily understood by the persons directly affected by it."

The proposed amendments to Rule 6-5 are written so that its meaning can be easily understood by the persons directly affected by them. Further details in the Staff Report clarify the proposals, delineate the affected industry, compliance options, and administrative requirements for the industries subject to this rule.

D. Consistency

The California Health and Safety Code Section 40727(b)(4) states that "'Consistency' means that the regulation is in harmony with, and not in conflict with or contradictory to, existing statutes, court decisions, or state or federal regulations."

The proposed amendments to Rule 6-5 are consistent with other Air District rules and not in conflict with state or federal law.

E. Non-Duplication

The California Health and Safety Code Section 40727(b)(5) states that "'Nonduplication' means that a regulation does not impose the same requirements as an existing state or federal regulation unless a district finds that the requirements are necessary or proper to execute the powers and duties granted to, and imposed upon, a district."

The proposed amendments to Rule 6-5 are non-duplicative of other statutes, rules or regulations.

F. Reference

The California Health and Safety Code Section 40727(b)(6) states that "'Reference' means the statute, court decision, or other provision of law that the district implements, interprets, or makes specific by adopting, amending, or repealing a regulation."

By adopting the proposed amendments to Rule 6-5, the Air District Board of Directors will be implementing, interpreting or making specific the provisions of California Health and Safety Code Sections 40000, 40001, 40702 and 40727.

The proposed amendments to Rule 6-5 have met all legal noticing requirements, have been discussed with the regulated community and other interested parties, and reflect consideration of the input and comments of many affected and interested stakeholders.

G. Recommendations

Air District staff recommends the Air District Board of Directors adopt the proposed amendments to Regulation 6, Rule 5: Particulate Emissions from Petroleum Refinery Fluidized Catalytic Cracking Units.

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Appendix A.1: Exposure and Health Equity Assessment for Rule 6-5

2021-05-19: *Promoted to final from interim draft.*

2021-03-25: *Minor revisions to version 2021-01-27, to reflect reordering and renumbering of Appendices within Appendix A.*

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Contents

I. Overview

This Appendix provides technical details regarding the exposure and health equity assessments presented in Section V. Starting from block-level population estimates (Appendices A.2 and A.3) and model-estimated, incremental fine particulate matter ($PM_{2.5}$) concentrations (Appendices A.4 and A.5), this appendix documents the calculation of:

1. Block-level, source-specific incremental $PM_{2.5}$ concentrations; and
2. Population-stratified, source-apportioned residential impacts ("exposures").

Unless otherwise noted, all computations and data transformations were carried out using the R programming language, version 3.6.

II. PM$_{2.5}$ Concentrations and Study Area

A. Input Data

CALPUFF output (Appendices A.4 and A.5) consists of modeled incremental concentrations assigned to the cells of a raster (that is, a regular grid) at 100m resolution. Figure 2, below, depicts the raster values for the "baseline" scenario. The outermost contour represents a contribution of +0.1 µg/m3, which as an order-of-magnitude is approximately 1% of the total ambient concentration within the general area.

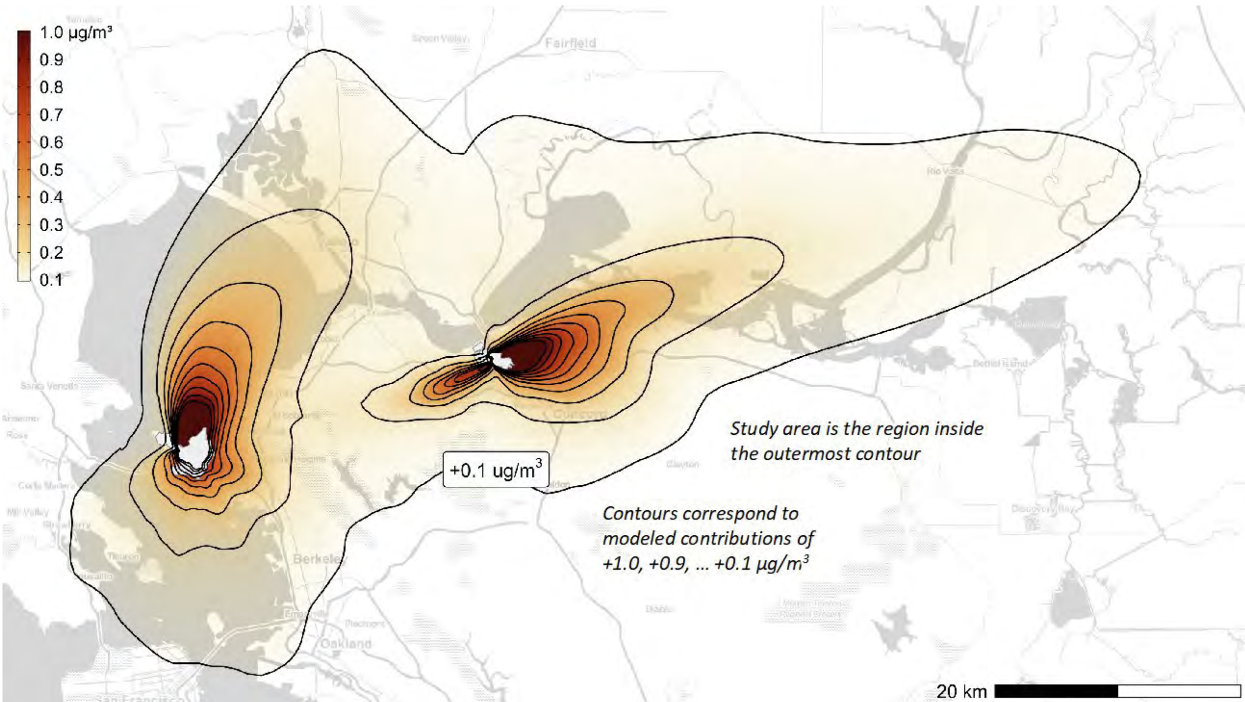

Figure 1. *Contributions of modeled baseline emissions to ambient PM$_{2.5}$. The outermost contour represents a contribution of +0.1 µg/m^3, which is approximately 1% of ambient PM$_{2.5}$ within the vicinity. Contributions less than +0.1 µg/m^3 (i.e., beyond the study area) are not shown. In this figure, all contributions larger than 1.0 µg/m^3 are shown using the same color—that is, the color scale is clamped to 1.0—but actual values were never clamped when computing exposures.*

B. Study Area

The +0.1 µg/m^3 contour illustrates the basis for the "study area", which scoped the subsequent population and exposure estimates. To be precise, the study area was taken to consist of all Census blocks for which the block-average PM$_{2.5}$ contribution (see next section) from all modeled baseline emissions combined was exactly 0.1 ug/m^3 or greater.[1]

[1] GIS operations were not used to intersect the contour with block polygons. The contour does encompass the set of block polygons that comprise the study area, but it also intersects some block polygons with an average concentration less than 0.1 ug/m3, which were omitted from the "study area".

III. Block-Level Average $PM_{2.5}$ Contributions

Let the cells of the CALPUFF raster be indexed by r, the blocks by i, and the contributing sources of $PM^{2.5}$ by k. Then the modeled "block-average" incremental concentration for block i, from source k, may be denoted X_{ik}. We calculated each X_{ik} as an area-weighted average[2] of the values assigned to raster cells X_{rk} as follows:

$$X_{ik} = \sum_{r} A(r, i) \cdot X_{rk}$$

… where $A(r, i)$ is the area-of-overlap function: zero if block i and cell r are non-overlapping, and otherwise equal to the fraction of block i that overlaps with cell r.[3] We operationalized this by using the *exactextractr* R package[4] to overlay the CALPUFF raster with Census-block polygons, creating these block-level averages. Raster cells within the facility boundaries (for both Chevron and PBF) were omitted from the overlay operation.

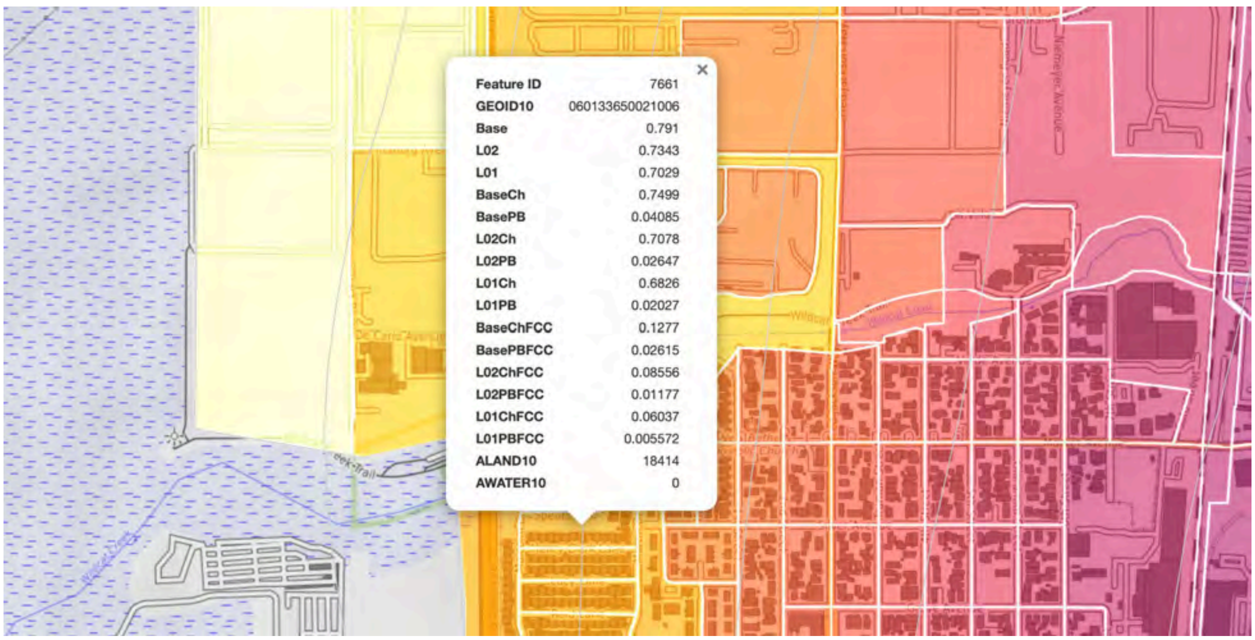

Figure 2. *Example: block-level averages of modeled contributions to ambient $PM_{2.5}$ for a randomly selected block in the vicinity of Henry Clark Ln (North Richmond neighborhood). Block boundaries, drawn in white, are from US Census (TIGER/LINE) data. Attributes beginning with `Base`, `L02`, and `L01` are block-level $PM_{2.5}$ averages assigned to the selected block for a given scenario (Base = Baseline; L02 = Scenario A; L01 = Scenario B). Attributes suffixed with `Ch` or `Pb` are specific to Chevron or PBF, while those suffixed with `FCC` represent contributions specifically attributed to FCCU emissions. Colors in this figure correspond to values of `Base`.*

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[2] This method effectively treats each X_{rk} as constant across cell r.

[3] Since the cells are non-overlapping, $\sum_r A(r, i) \leq 1$ for each and every block i. For the blocks that comprise the "study area" ($i \in I$; see text) $\sum_r A(r, i) = 1$ for all i.

[4] https://cran.r-project.org/web/packages/exactextractr/index.html

IV. Block-Level Populations

Block-level population estimates were created using PopGrid, a tool that is part of the US EPA BenMAP platform. (See Appendices A.2 and A.3 for details.) These were imported into R and joined, at the block level, to the PM2.5 averages described in the previous section.

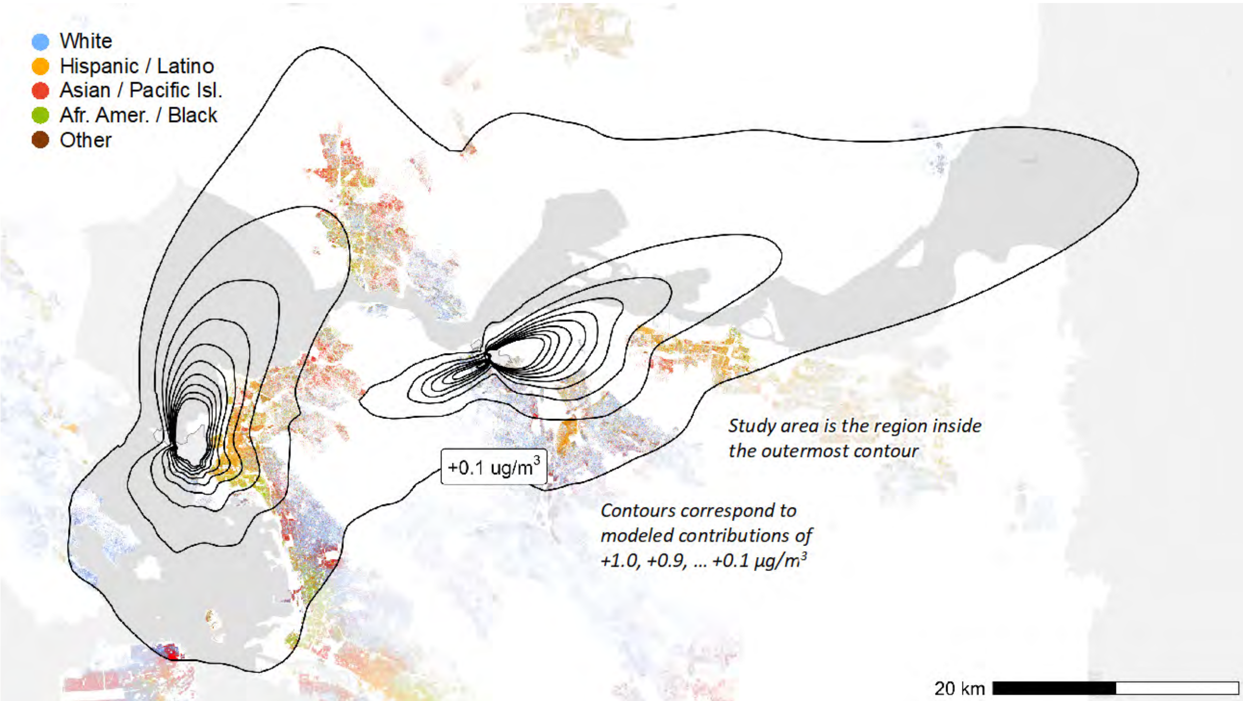


Figure 3. *Each dot corresponds to one resident; colors correspond to US Census race/ethnicity categories. Approximately 1 million people reside in the study area.*

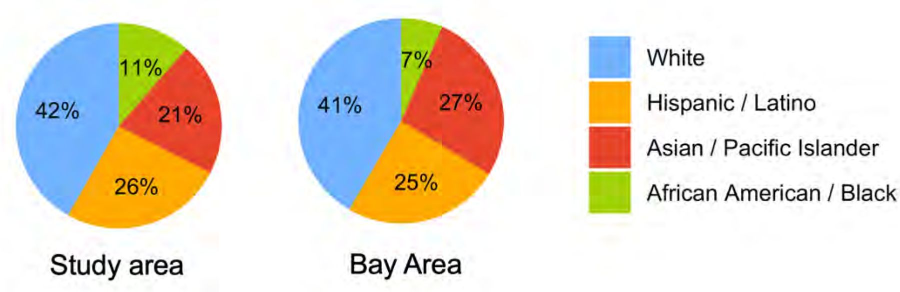


Figure 4. *Demographics. Not shown: 0.3% Native American / Alaska Native (both charts).*

V. Exposure by Race/Ethnicity

A. Population Exposure

For each combination of {Scenario, Facility, Source, RaceEth, Block}, we computed the product of population and average $PM_{2.5}$, and then summed these across blocks. This yielded estimates of population exposure (person-µg/m³) for the entire study area, indexed by {Scenario, Facility, Source, RaceEth}, as depicted in the figure below.

Figure 5a. *Modeled estimates of total population exposure (residential impact) within the study area. Within each of the eight panels, there are three bars. The leftmost bar corresponds to the baseline scenario. The middle and rightmost bars correspond to scenarios where emissions from the FCCU have been reduced. Bar heights correspond to total impacts from all modeled sources; the darker portions of the bars correspond to the shares of those impacts that are specifically attributed to FCCU emissions.*

B. Exposure "Per Capita"

For each combination of {Scenario, Facility, Source, RaceEth}, we also calculated population-weighted averages of block-level $PM_{2.5}$ estimates, using block populations (specific to a particular RaceEth category) as the weight. This yielded "average" or "per capita" exposure intensities indexed by {Scenario, Facility, Source, RaceEth}, depicted in the figures below. Estimates specific to source but not facility—that is, aggregating the two facilities together—were computed by the same operation, but omitting Facility from the set of indexing (i.e., grouping) variables.

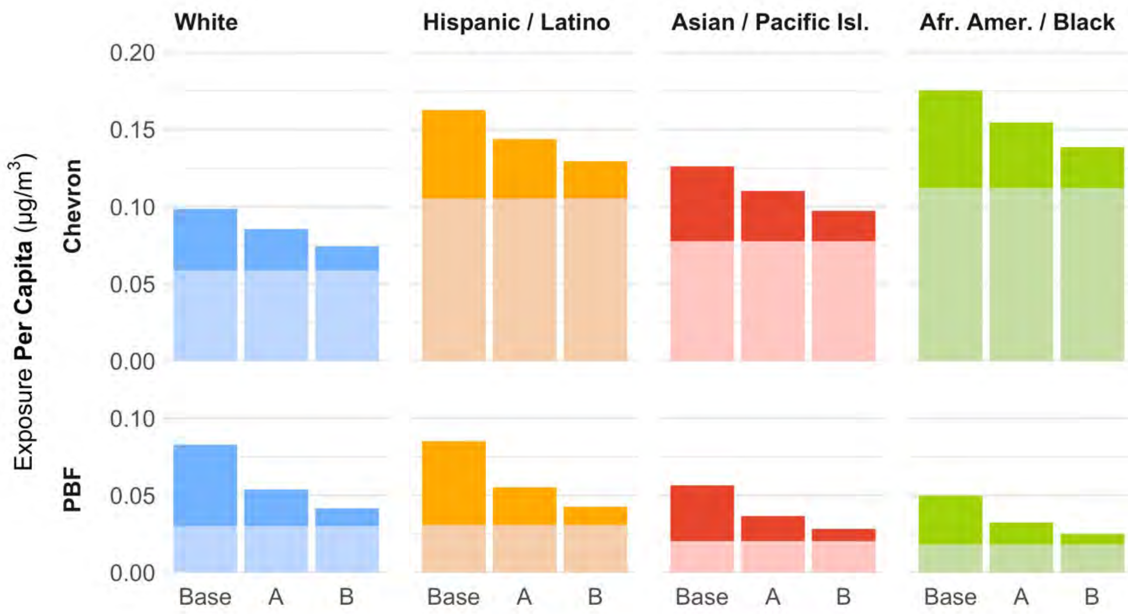


Figure 5b. *Same as previous, except that the y-axes have been normalized by population, yielding bar heights that correspond to average (that is, "per capita") impacts.*

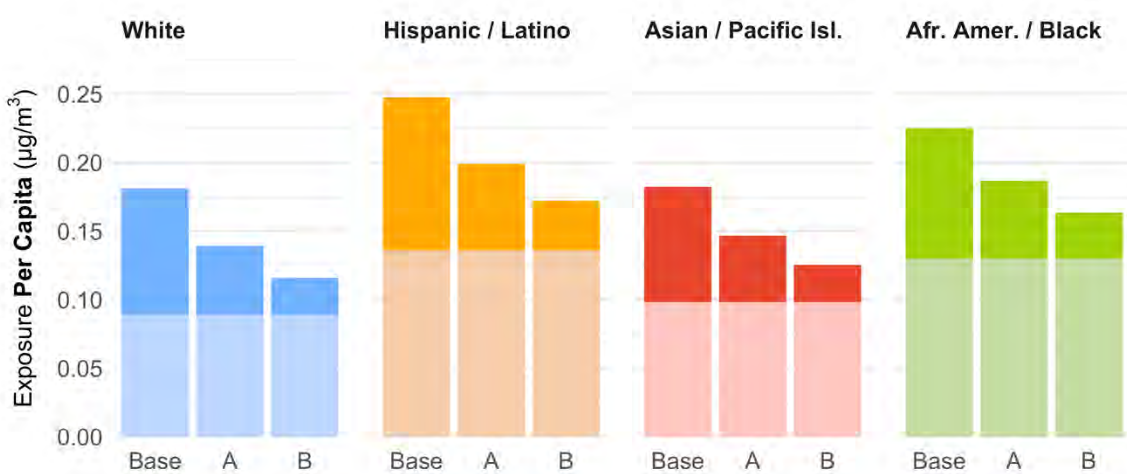


Figure 5c. *Same as previous, except that impacts from both facilities have been combined.*

Appendix A.2:

Modeling Fine Particulate Matter Emissions from the Chevron Richmond Refinery: An Air Quality Health Impact Analysis (Version 2)

Version 2 promoted to final from interim draft.

Updates since version 1: Minor changes and corrections to footnotes in Tables ES1 and 4.1; added text to acknowledge adjustments to 2018 baseline emissions to reflect facility changes since 2018.

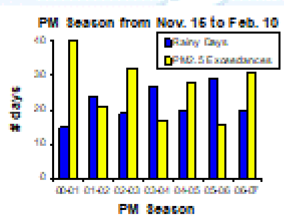
BAY AREA AIR QUALITY MANAGEMENT DISTRICT
375 Beale Street, San Francisco, CA 94105

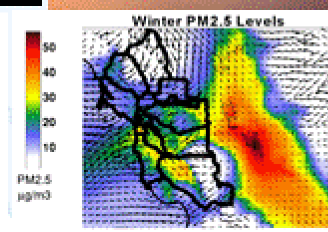
Air Quality Modeling and Analysis Section Publication No. 202103-022-PM

Modeling Fine Particulate Matter Emissions From the Chevron Richmond Refinery: An Air Quality Health Impact Analysis (Version 2)

March 2021







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Executive Summary

The Bay Area Air Quality Management District (District) has conducted modeling analyses to assess the air quality and health impacts of fine particulate matter ($PM_{2.5}$) emissions from the Chevron Refinery in Richmond, California. These analyses are part of a larger effort to estimate the impacts of $PM_{2.5}$ emissions from major industrial facilities in the Bay Area. This work will support the District's rule development efforts and community-scale assessments conducted under Assembly Bill 617 (AB 617), which established collaborative programs to reduce disparities in air pollution exposure across California.

The California Puff (CALPUFF) model was used for estimating ambient $PM_{2.5}$ concentrations from Chevon refinery emissions. CALPUFF was applied at two spatial scales: a 1-km grid covering the entire Bay Area and a 100-m grid covering a smaller study area. The model was run using emission estimates derived from a base-year 2018 inventory but with adjustments to reflect facility changes since 2018. (See Koo et al., 2021a, for a discussion of emissions adjustments.) Year-specific meteorological inputs for three years (2016–2018) were utilized to minimize the impact of year-to-year variations in meteorology on estimated $PM_{2.5}$ levels. Average results from the three annual simulations were used as inputs to the US Environmental Protection Agency's Benefits Mapping and Analysis Program – Community Edition (BenMAP–CE), which estimates health impacts associated with changes in ambient pollutant levels, as well as conventional valuations of those impacts (expressed in US dollars).

BenMAP–CE was applied for three scenarios at the Census block level across the 100-m grid that defined the study area. The baseline scenario assessed the impacts of $PM_{2.5}$ emitted from all modeled sources at the Chevron refinery. Scenarios A and B respectively assessed reductions in these impacts due to the achievement of PM_{10} limits under Control Scenario A (0.020 gr/dscf) and Control Scenario B (0.010 gr/dscf) at the refinery's fluidized catalytic cracking unit (FCCU).

As modeled, 5.1 to 11.6 premature deaths per year were attributed to baseline $PM_{2.5}$ emissions from the Chevron refinery. The conventional valuation of all the health impacts included in our assessment (including, but not limited to, those deaths) was 52.5 to 118 million US dollars per year. The implementation of controls to achieve Control Scenario A and Control Scenario B at the refinery's FCCU were estimated to reduce annual excess deaths by 13% and 23%, respectively, and resulted in benefits valued at 6.8 to 15.2 and 12.2 to 27.4 million dollars per year, respectively.

The valued benefits represent US EPA's national average valuation, and were not modified specifically for the Bay Area. Table ES.1 summarizes the health and monetary impacts of $PM_{2.5}$ from Chevron Richmond refinery emissions along with percent changes due to emissions controls.

Table ES.1: Summary of health and monetary impacts of $PM_{2.5}$ from Chevron Richmond refinery emissions and percent change of FCCU emissions under Control Scenario A and Control Scenario B.

Baseline Health Impact[1] of Chevron Richmond Refinery (Annual)		Valuation[2] (Annual)	Reduction under Control Scenario A	Reduction under Control Scenario B
Cardiovascular	0.5–4.3 heart attacks	$63 k–$600 k	−13%	−22%
	1.0 hospital admissions	$47 k	−13%	−22%
Restricted Activity	4,800 days	$360 k	−12%	−21%
Lost Work	820 days	$190 k	−12%	−21%
Asthma	200 exacerbations[3]	$12 k	−12%	−21%
	4 emergency room visits	$2 k	−12%	−21%
	0.1 hospital admissions	$1 k	−12%	−20%
Respiratory Illness[4]	140 upper tract[3]	$5 k	−12%	−20%
	100 lower tract[3]	$2 k	−12%	−20%
	8 bronchitis[3]	$4 k	−12%	−20%
	0.2 chronic lung disease	$5 k	−12%	−21%
Mortality[5]	5.1–11.6 premature deaths	$52.5 M–$118 M	−13%	−23%
			$6.8 M/yr to $15.2 M/yr	**$12.2 M/yr to $27.4 M/yr**

[1] On the study population (about 1 million people)
[2] Conventional US EPA valuations, in 2015 US dollars
[3] Subset of pediatric (≤ 18 years)
[4] Other than asthma
[5] Including infant mortality
k, thousand; M, million.

List of Acronyms

AB 617	Assembly Bill 617
BAAQMD	Bay Area Air Quality Management District
BenMAP–CE	Benefits Mapping and Analysis Program – Community Edition
CALPUFF	California Puff (model)
CDC	Center for Disease Control
ESP	Electrostatic Precipitator
EPA	Environmental Protection Agency
FCCU	Fluidized Catalytic Cracking Unit
$PM_{2.5}$	Particulate Matter 2.5 micrometers or less in diameter
WGS	Wet Gas Scrubber

Modeling Fine Particulate Matter Emissions
From the Chevron Richmond Refinery:
An Air Quality Health Impact Analysis
(Version 2)

Introduction

The adoption of Assembly Bill 617 (AB 617) established collaborative programs to reduce community exposure to air pollutants in neighborhoods most impacted by air pollution. Air District staff have been working closely with the California Air Resources Board (CARB), other state agencies, local air districts, community groups, community members, environmental organizations, regulated industries, and other key stakeholders to reduce harmful air pollutants in Bay Area communities.

As part of these programs, Air Quality Modeling and Analysis Section staff have been estimating concentrations of directly emitted fine particulate matter ($PM_{2.5}$) from major industrial facilities in the Bay Area. This information is being used to estimate the contributions of emitted $PM_{2.5}$ to ambient levels, assess the adverse impacts of those contributions on human health and welfare, and quantify the benefits of reducing those impacts through emission controls.

Atmospheric $PM_{2.5}$ is a complex mixture of suspended particles and liquid droplets having aerodynamic diameters of 2.5 µm or less. These particles are small enough to be inhaled into the lungs and thereby enter the bloodstream. Numerous studies have reported that $PM_{2.5}$ is deleterious to the respiratory and cardiovascular systems. In the lungs, $PM_{2.5}$ aggravates asthma, bronchitis, and other respiratory problems, leading to increased hospital admissions. In the heart and vascular system, $PM_{2.5}$ is associated with chronic hardening of the arteries (atherosclerosis) and triggering of heart attacks (acute myocardial infarctions). Decreased life expectancy, potentially on the order of years, has been documented.

The United States Environmental Protection Agency (US EPA) has developed the Environmental Benefits Mapping and Analysis Program – Community Edition (BenMAP–CE) to estimate and quantify conventional valuations of health impacts associated with changes in ambient pollutant levels (US EPA, 2018). Staff of the Air Quality Modeling and Analysis Section have been applying this program to estimate adverse impacts of $PM_{2.5}$ on Bay Area residents (Tanrikulu, et al., 2011). This program is also being used to assess the impacts of $PM_{2.5}$ emitted from major industrial facilities in the Bay Area.

The impacts of $PM_{2.5}$ from Chevron Richmond refinery emissions were analyzed for this report. The impacts of emissions from other major facilities will be reported separately.

Materials and methods

2.1 US EPA's BenMAP–CE computer program

In this study, BenMAP–Community Edition (BenMAP–CE), version 1.5, was used (https://www.epa.gov/benmap). This program was designed to estimate changes in human health due to changes in ambient air quality for specific populations and to estimate conventional valuations of these impacts (in US dollars).

The valuation process takes into account both the direct costs of illnesses such as actual medical costs and lost worker hours and indirect costs reflecting *willingness to pay* to avoid pain and suffering as well as premature death. The direct costs alone may substantially underestimate the total valuation assigned to reductions in these outcomes. For pollutants capable of causing death, such as $PM_{2.5}$, the mortality-based component tends to far outweigh the morbidity-based component. The calculations implemented by BenMAP–CE include assessing the change in population exposure, using health impact functions to estimate the incremental change in selected human health outcomes based on the exposure difference, and evaluating the range of monetary valuations associated with these outcomes.

Epidemiological data are used to develop concentration–response functions, which BenMAP–CE uses to quantify the linkages between pollutant exposures and adverse health outcomes. These functions are typically stratified by population subgroups (e.g., age groups) and account for the effects associated with a specific duration and degree of pollutant exposure. Population data and pollutant concentration data input to BenMAP–CE must be prepared in a manner consistent with these concentration–response functions. Epidemiological data linking $PM_{2.5}$ exposure and mortality are typically stratified by age group (e.g., infants, 18 years of age and older, etc.) and reflect an annual averaging period.

The BenMAP–CE program overlays population data onto changes in ambient pollutant concentrations to calculate spatially resolved impacts associated with pollutant exposure. Pollutant concentration data are taken from air quality model simulations or observations.

The study described in this report was the first of its kind to use high-resolution simulated pollutant fields to evaluate $PM_{2.5}$ health impacts over the Bay Area. High-resolution simulations reproduced the sharp spatial gradients in pollutant concentrations that result in significant neighborhood-to-neighborhood differences in human exposures.

An alternative approach would be to use air monitoring data. This approach would require interpolating pollutant levels from a network of monitors to construct levels over unmonitored neighborhoods. Since air monitoring data include concentrations from emissions of all sources, this approach is not applicable to our project that assesses health impacts of emissions from a specific source or proposed or adopted emissions control.

Applications of BenMAP–CE require the development of two sets of inputs: ambient $PM_{2.5}$ concentrations and population data. The preparation of these datasets for this study is discussed below.

2.2 Preparation of $PM_{2.5}$ concentrations

The California Puff (CALPUFF) model was used for estimating ambient $PM_{2.5}$ concentrations from Chevron Richmond refinery emissions (Koo et al., 2021a) and from PBF Martinez refinery emissions (Koo et al., 2021b). CALPUFF estimates pollutant concentrations at predefined receptor locations. Two receptor domains were established for the simulations. One covered the entire Bay Area at 1-km grid resolution, and the other covered a smaller area at 100-m grid resolution.

Results from the larger domain encompassing emissions from both Chevron Richmond and the PBF Martinez refineries were used to establish a “study area” approximating a “refinery corridor.” This study area, consisting of the union of Census blocks for which an average modeled contribution (from both facilities combined) was determined to meet or exceed 0.1 $\mu g/m^3$ $PM_{2.5}$, was used to scope the residential population for which impacts were assessed.

CALPUFF was applied for three years (2016, 2017, and 2018) using year-specific meteorology and the same base-year (2018) emission estimates that included all inventoried $PM_{2.5}$ emissions from the refineries. The average results from the three annual simulations were used for health impacts analyses to minimize the effects of year-to-year variability in meteorology on ambient $PM_{2.5}$ levels. The average concentrations from the baseline simulation of the Chevron Richmond refinery are shown in Figure 2.1.

CALPUFF was also applied for two additional simulations for the same years and the resulting concentrations were averaged in the same manner as described above: (1) a simulation with emissions only from the refinery’s fluidized catalytic cracking unit (FCCU) and (2) a simulation with emissions only from the refinery’s FCCU controlled with an assumed wet gas scrubber (WGS). Air District staff believes that the more stringent 0.010 gr/dscf standard under Control Scenario B could only be met with a wet gas scrubber.

Analyses were also conducted for an assumed emissions rate corresponding to the 0.020 gr/dscf standard under Control Scenario A. Air District staff assumes stack release parameters would remain consistent with the current refinery configuration. For this scenario, concentrations estimated with the FCCU emissions only was uniformly reduced 33%, and the resulting concentrations were subtracted from the base simulation. This percent reduction is consistent with the 0.020 gr/dscf standard. Figure 2.2a shows reductions in $PM_{2.5}$ concentrations due to the 0.020 gr/dscf standard (scenario A). Figure 2.2b shows reductions in $PM_{2.5}$ concentrations due to the 0.010 gr/dscf standard (assuming WGS control) from the Chevron Richmond refinery (scenario B).

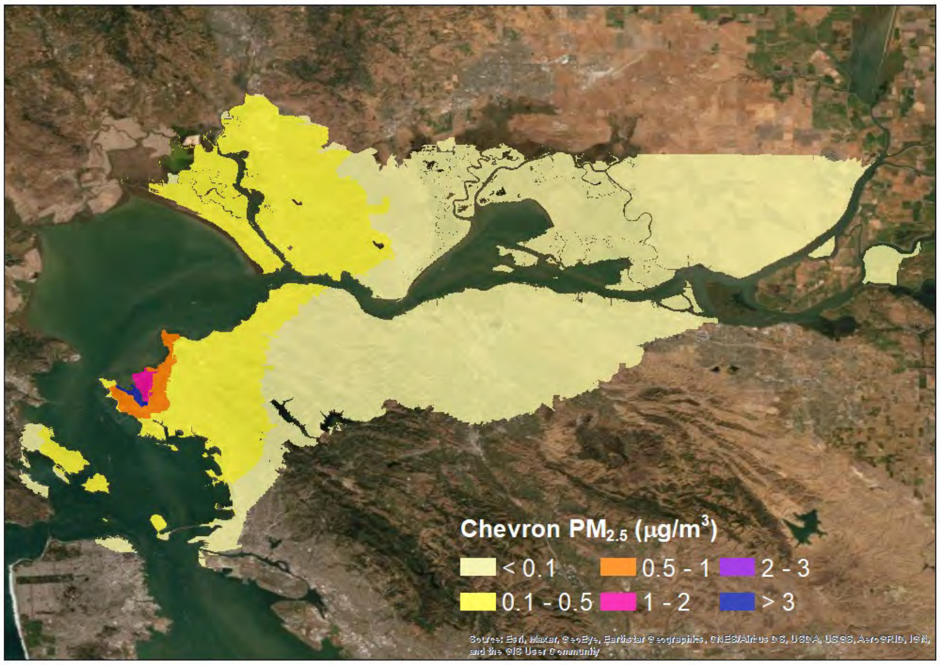

Figure 2.1: Average $PM_{2.5}$ concentrations from the baseline scenario for the Chevron Richmond refinery.

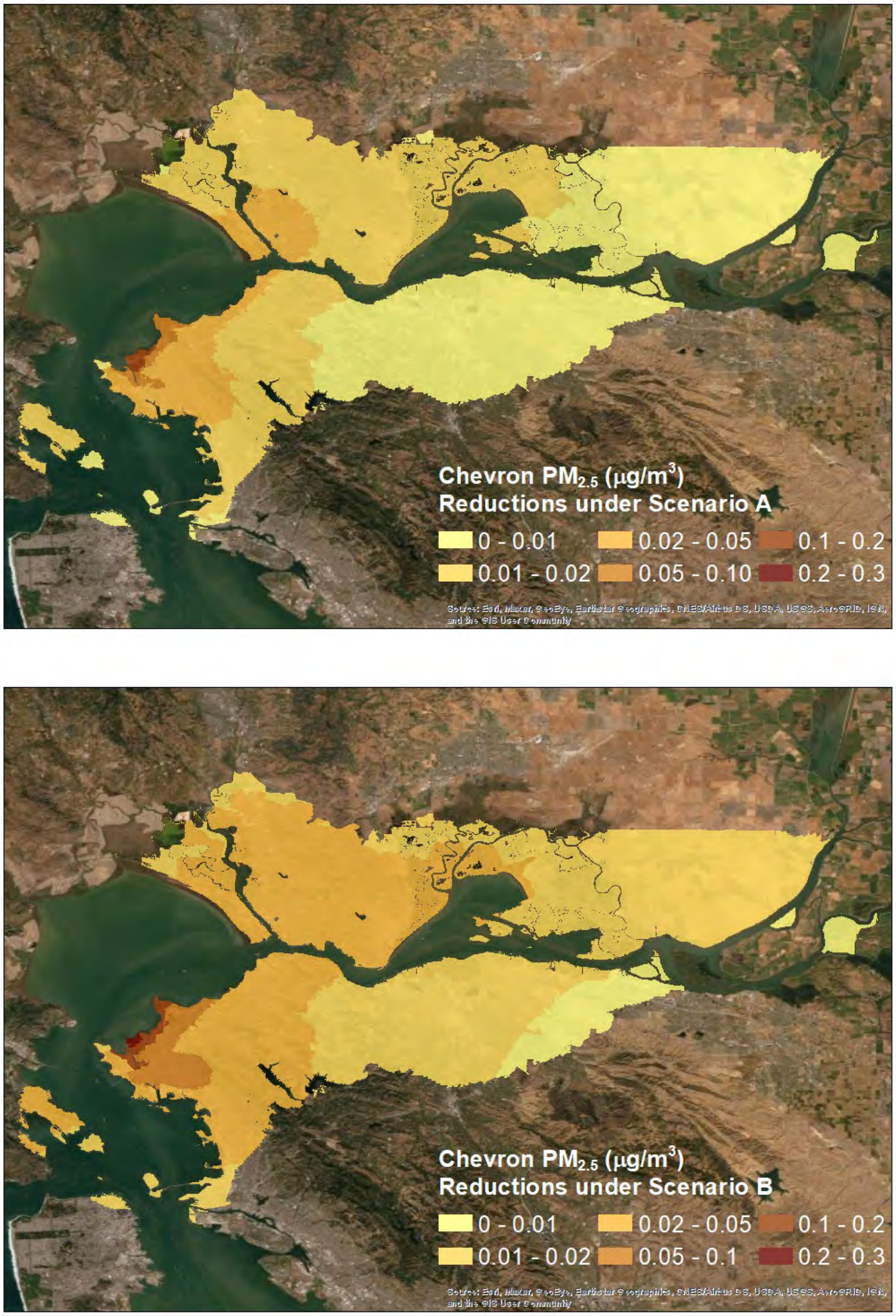

Figure 2.2: (a) Reductions in average $PM_{2.5}$ concentrations due to 0.020 gr/dscf standard (upper panel, Control Scenario A); (b) reductions in average $PM_{2.5}$ concentrations due to 0.010 gr/dscf standard (lower panel, Control Scenario B).

BenMAP–CE requires two sets of ambient concentrations to estimate health impacts. These are called base and control cases. CALPUFF simulations were designed to estimate: (1) the overall health impacts of $PM_{2.5}$ emitted from the Chevron Richmond refinery, and (2) the benefits of reducing FCCU emissions under Control Scenario A and Control Scenario B. For estimating overall health impacts, the base case was the three-year average simulated $PM_{2.5}$ concentrations from all Chevron emissions, while the control case was simply an assumed concentration field with zero $PM_{2.5}$ (i.e., no emissions from Chevron) for comparison; the difference between these two cases provided a representation of the $PM_{2.5}$ contribution associated with total Chevron emissions.

For estimating the benefits of reducing FCCU emissions, the base case was the three-year average simulated $PM_{2.5}$ concentrations from uncontrolled FCCU emissions, while the control cases were the $PM_{2.5}$ concentration field resulting from the Control Scenario A and Control Scenario B emissions.

BenMAP–CE provides population data from the 2010 Census at both the Census block and Census tract levels. Block-average $PM_{2.5}$ contributions were assigned to each Census block in the study area. Figure 2.3 illustrates the set of such blocks. For details of the calculation of block averages, see Holstius and Martien, 2021.

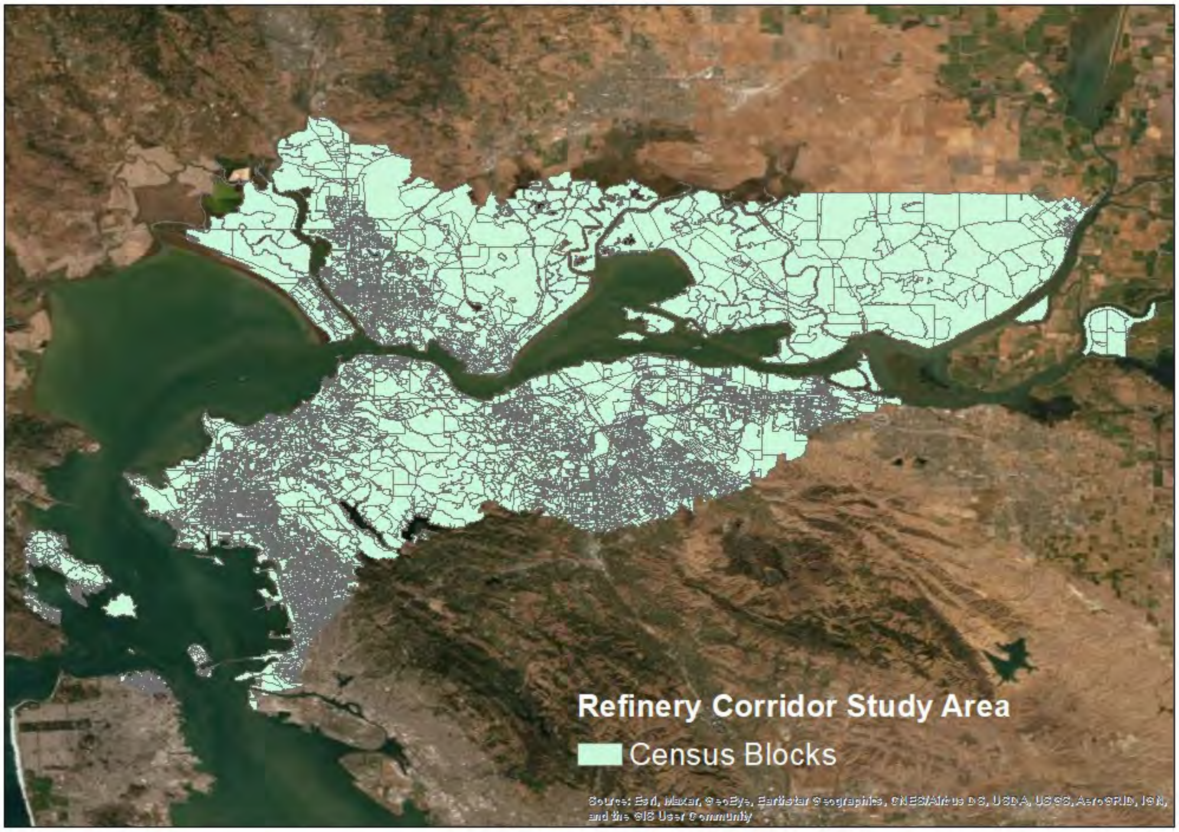

Figure 2.3: Map of the study area and all Census blocks included in the BenMAP–CE analysis.

2.3 Preparation of population data

BenMAP–CE requires population data to be grouped in a specific way to apply the available health impact functions. The developers of BenMAP–CE had already grouped the US Census Bureau's population data for this purpose for 2010, a year the most comprehensive census was conducted (Table 2.1). We projected the 2010 data to 2020 using an available module in BenMAP-CE, Figure 2.4.

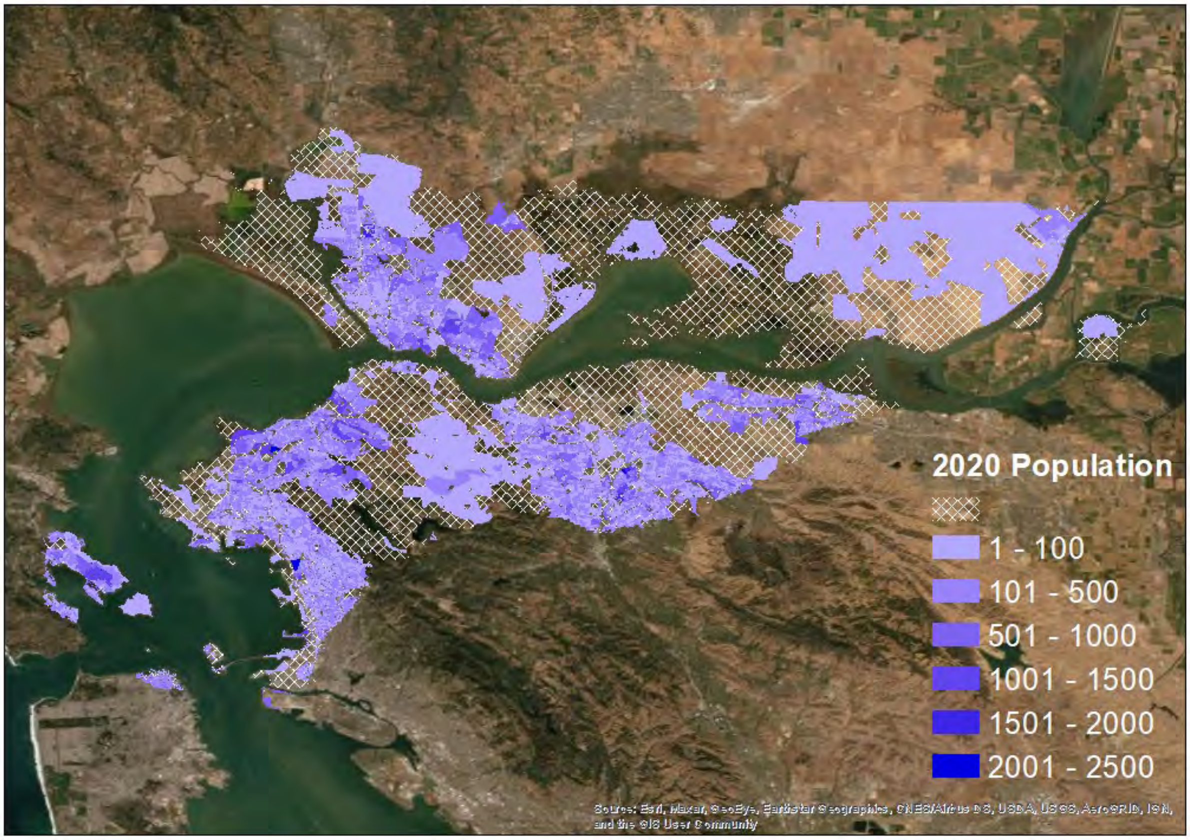

Figure 2.4: Projected 2020 population obtained by applying PopGrid to 2010 Census data.

As can be seen from Table 2.1, there were a total of 304 population groups for which $PM_{2.5}$ health impacts could be estimated. They comprised nineteen age, four race, two ethnic, and male and female groups (details of how these groups were established are provided in Appendix J of EPA 2018). BenMAP's racial classification schema is identical to that of the Center for Disease Control (CDC), from which BenMAP obtains baseline health data. CDC's schema is aligned with the US Census 2010 schema, except that multi-racial ("2 or more races," etc.) as well as "other race" responses are reclassified into one of these four "single-race" bins based on auxiliary data.[1] Thus, multiracial and other classifications have not been dropped; they have been reclassified into one of these four categories.

[1] This practice, termed "race bridging," is a convention followed by the CDC to support long-term trend analyses.

Table 2.1: BenMAP–CE population groupings.

Age	Race	Ethnicity	Sex
<1, 1–4, 5–9, 10–14, 15–19, 20–24, 25–29, 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, 80–84, 85+	White African American Asian American Indian	Hispanic Non-Hispanic	Male Female

Application of BenMAP–CE

BenMAP–CE was applied for three different scenarios at the Census block level across the study area, as shown in Table 3.1. The first scenario, the baseline scenario, assessed the total impacts of $PM_{2.5}$ emitted from all modeled sources at the Chevron Richmond refinery. Scenarios A and B assessed reductions in these impacts due to achieving PM_{10} standards of 0.020 gr/dscf and 0.010 gr/dscf at the FCCU, respectively.

Table 3.1: BenMAP–CE application scenarios.

Scenario	Domain	Base Case	Control Case
Baseline	Study area (Census block level)	$PM_{2.5}$ emissions from all Chevron sources	All $PM_{2.5}$ concentrations set to zero (no emissions from Chevron)
A	Study area (Census block level)	$PM_{2.5}$ emissions from all Chevron sources	$PM_{2.5}$ emissions from all Chevron sources, but with FCCU emissions controlled to 0.020 gr/dscf standard
B	Study area (Census block level)	$PM_{2.5}$ emissions from all Chevron sources	$PM_{2.5}$ emissions from all Chevron sources, but with FCCU emissions controlled to 0.010 gr/dscf standard

BenMAP–CE was run using the same set of health impact functions used by the US EPA to assess $PM_{2.5}$ impacts in the United States, except for functions related to premature mortality. For the premature mortality category, we added three health impact functions to the EPA's set to ensure that the premature mortality endpoint was evaluated rigorously. Two of the added functions are from Jerrett et al., 2013 and are based on California-wide and nationwide analyses of a 1980–2000 cohort. The third added function is from Vodonos et al., 2018, which itself is a meta-analysis summarizing 53 single studies (including the three other studies that we included), 17 of which have been published since 2015.

Table 3.2 summarizes the health impact functions used in BenMAP–CE and also provides information on the health endpoints associated with each study, age range, and baseline health data used.

Table 3.2: Health endpoint, studies developed health impacts functions and epidemiological data used.

Health Endpoint	Studies Developed Health Impacts Functions	Study Population	Baseline Health Data as Named in BenMAP–CE
Cardiovascular			
Nonfatal heart attacks	Peters et al. (2001)	18+ years	Other incidence (2014)
	Pooled estimate: -Pope et al. (2006) -Sullivan et al. (2005) -Zanobetti et al. (2009) -Zanobetti and Schwartz (2006)	18+ years	Other incidence (2014)
Hospital admission, cardiovascular	Pooled estimate: -Zanobetti et al. (2009) -Peng et al. (2009) -Peng et al. (2008) -Bell et al. (2008)	64+ years	Other incidence (2014)
	Moolgavkar (2000)	18–64 years	Other incidence (2014)
Lost Work			
Work loss days	Ostro (1987)	18–65 years	Other incidence (2000)
Restricted Activity			
Minor restricted activity days	Ostro and Rothschild (1989)	18–65 years	Literature data
Asthma			
Asthma exacerbations	Pooled estimate: -Ostro et al. (2001) -Mar et al. (2004)	6–18 years	Prevalence (2008)

Health Endpoint	Studies Developed Health Impacts Functions	Study Population	Baseline Health Data as Named in BenMAP–CE
Asthma-related ER visits	Pooled estimate: -Mar et al. (2010) -Slaughter et al. (2005) -Glad et al. (2012)	All ages	Other incidence (2014)
Hospital admission, asthma	Pooled estimate: -Babin et al. (2007) -Sheppard (2003)	0–17 years	Other incidence (2014)
Respiratory illness			
Upper respiratory symptoms	Pope et al. (1991)	Asthmatics, 9–11 years	Prevalence (2008)
Lower respiratory symptoms	Schwartz and Neas (2000)	7–14 years	Literature data
Acute bronchitis	Dockery et al. (1996)	8–12 years	Other incidence (2000)
Hospital admission, chronic lung disease	Moolgavkar (2000)	18–64 years	Other incidence (2014)
Mortality			
Mortality, all-cause	Krewski et al. (2009) Lepeule et al. (2012) Woodruff et al. (1997)	30+ years 25+ years Infant (<1 year)	Mortality incidence (2020)
Mortality, all-cause (added to BenMAP–CE)	Jerrett et al. (2013) for CA Jerrett et al. (2013) for US Vodonos et al. (2018)	30+ years 30+ years All ages	Mortality incidence (2020)

Results

Results obtained from BenMAP–CE are tabulated in Table 4.1 using the US EPA's pooling method. This method allows users to summarize health and monetary impacts from changes in $PM_{2.5}$ concentrations. BenMAP–CE results showed that $PM_{2.5}$ emissions from the Chevron Richmond refinery result in 5.1 to 11.6 premature deaths per year, valued at 52.5 to 118 million US dollars. Achievement of the standards under Control Scenario A and Control Scenario B at the refinery's FCCU were estimated to reduce annual excess deaths by 13% and 23%, respectively, and result in benefits valued at 6.8 to 15.2 and 12.2 to 27.4 million dollars per year, respectively. The range in the valuations shown, for both the baseline and the control benefits, is mostly attributable to the range in mortality impacts from the different health impact functions applied.

Table 4.1: Summary of health and monetary impacts of $PM_{2.5}$ from Chevron Richmond refinery emissions and percent change of FCCU emissions under Control Scenario A and Control Scenario B.

Baseline Health Impact[1] of Chevron Richmond Refinery (Annual)		**Valuation[2] (Annual)**	**Reduction under Control Scenario A**	**Reduction under Control Scenario B**
Cardiovascular	0.5–4.3 heart attacks	\$63 k–\$600 k	−13%	−22%
	1.0 hospital admissions	\$47 k	−13%	−22%
Restricted Activity	4,800 days	\$360 k	−12%	−21%
Lost Work	820 days	\$190 k	−12%	−21%
Asthma	200 exacerbations[3]	\$12 k	−12%	−21%
	4 emergency room visits	\$2 k	−12%	−21%
	0.1 hospital admissions	\$1 k	−12%	−20%
Respiratory Illness[4]	140 upper tract[3]	\$5 k	−12%	−20%
	100 lower tract[3]	\$2 k	−12%	−20%
	8 bronchitis[3]	\$4 k	−12%	−20%
	0.2 chronic lung disease	\$5 k	−12%	−21%
Mortality[5]	5.1–11.6 premature deaths	\$52.5 M–\$118 M	−13%	−23%
			\$6.8 M/yr to \$15.2 M/yr	**\$12.2 M/yr to \$27.4 M/yr**

[1] On the study population (about 1 million people)
[2] Conventional US EPA valuations, in 2015 US dollars
[3] Subset of pediatric (≤ 18 years)
[4] Other than asthma
[5] Including infant mortality
k, thousand; M, million.

Note that valued benefits shown in Table 4.1 represent US EPA's national average valuation, and were not modified specifically for the Bay Area.

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Appendix A.3:

Modeling Fine Particulate Matter Emissions from the PBF Martinez Refinery: An Air Quality Health Impact Analysis (Version 2)

Version 2 promoted to final from interim draft.

Updates since version 1: Appendix A.3 reordered within Appendix A. Minor changes and corrections to footnotes in Tables ES1 and 4.1

Bay Area Air Quality Management District
375 Beale Street, San Francisco, CA 94105

Air Quality Modeling and Analysis Section Publication No. 202103-023-PM

Modeling Fine Particulate Matter Emissions From the PBF Martinez Refinery: An Air Quality Health Impact Analysis (Version 2)

March 2021

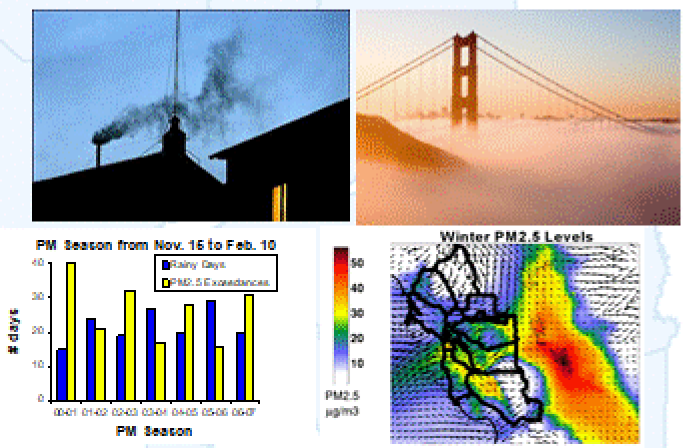

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Table of Contents

Executive Summary

The Bay Area Air Quality Management District (District) has conducted modeling analyses to assess the air quality and health impacts of fine particulate matter ($PM_{2.5}$) emissions from the PBF Refinery in Martinez, California. These analyses are part of a larger effort to estimate the impacts of $PM_{2.5}$ emissions from major industrial facilities in the Bay Area. This work will support the District's rule development efforts and community-scale assessments conducted under Assembly Bill 617 (AB 617), which established collaborative programs to reduce disparities in air pollution exposure across California.

The California Puff (CALPUFF) model was used for estimating ambient $PM_{2.5}$ concentrations from PBF refinery emissions. CALPUFF was applied at two spatial scales: a 1-km grid covering the entire Bay Area and a 100-m grid covering a smaller study area. The model was run using a single set of base-year (2018) emissions estimates. Year-specific meteorological inputs for three years (2016–2018) were utilized to minimize the impact of year-to-year variations in meteorology on estimated $PM_{2.5}$ levels. Average results from the three annual simulations were used as inputs to the US Environmental Protection Agency's Benefits Mapping and Analysis Program – Community Edition (BenMAP–CE), which estimates health impacts associated with changes in ambient pollutant levels, as well as conventional valuations of those impacts (expressed in US dollars).

BenMAP–CE was applied for three scenarios at the Census block level across the 100-m grid that defined the study area. The baseline scenario assessed the impacts of $PM_{2.5}$ emitted from all modeled sources at the PBF refinery. Scenarios A and B respectively assessed reductions in these impacts due to the achievement of PM_{10} limits under Control Scenario A (0.020 gr/dscf) and Control Scenario B (0.010 gr/dscf) at the refinery's fluidized catalytic cracking unit (FCCU).

As modeled, 2.8 to 6.3 premature deaths per year were attributed to baseline $PM_{2.5}$ emissions from the PBF refinery. The conventional valuation of all the health impacts included in our assessment (including, but not limited to, those deaths) was 28.8 to 64.9 million US dollars per year. The implementation of controls to achieve Control Scenario A and Control Scenario B at the refinery's FCCU were estimated to reduce annual excess deaths by 35% and 50%, respectively, and resulted in benefits valued at 10.1 to 22.7 and 14.4 to 32.4 million dollars per year, respectively.

The valued benefits represent US EPA's national average valuation, and were not modified specifically for the Bay Area. Table ES.1 summarizes the health and monetary impacts of $PM_{2.5}$ from PBF Martinez refinery emissions along with percent changes due to emissions controls.

Table ES.1: Summary of health and monetary impacts of $PM_{2.5}$ from PBF Martinez refinery emissions and percent change of valuation for FCCU emissions under Control Scenario A and Control Scenario B.

Baseline Health Impact[1] of PBF Martinez Refinery (Annual)		Valuation[2] (Annual)	Reduction under Control Scenario A	Reduction under Control Scenario B
Cardiovascular	0.3–2.4 heart attacks	$37 k–350 k	-35%	-50%
	0.6 hospital admissions	$26 k	-35%	-50%
Restricted Activity	2,700 days	$200 k	-35%	-50%
Lost Work	460 days	$100 k	-35%	-50%
Asthma	110 exacerbations[3]	$7 k	-35%	-50%
	2 emergency room visits	$1 k	-35%	-50%
	<0.1 hospital admissions	$1 k	-35%	-50%
Respiratory Illness[4]	80 upper tract[3]	$3 k	-35%	-50%
	50 lower tract[3]	$1 k	-35%	-50%
	4 bronchitis[3]	$2 k	-35%	-50%
	0.1 chronic lung disease	$3 k	-35%	-50%
Mortality[5]	2.8–6.3 deaths	$28.8 M–64.9 M	-35%	-50%
			$10.1 M to $22.7 M/yr	**$14.4 M to $32.4 M/yr**

[1] On the study population (about 1 million people)
[2] Conventional US EPA valuations, in 2015 US dollars
[3] Subset of pediatric (≤ 18 years)
[4] Other than asthma
[5] Including infant mortality
k, thousand; M, million.

List of Acronyms

AB 617	Assembly Bill 617
BAAQMD	Bay Area Air Quality Management District
BenMAP–CE	Benefits Mapping and Analysis Program – Community Edition
CALPUFF	California Puff (model)
CDC	Center for Disease Control
ESP	Electrostatic Precipitator
EPA	Environmental Protection Agency
FCCU	Fluidized Catalytic Cracking Unit
$PM_{2.5}$	Particulate Matter 2.5 micrometers or less in diameter
WGS	Wet Gas Scrubber

Modeling Fine Particulate Matter Emissions
From the PBF Martinez Refinery:
An Air Quality Health Impact Analysis
(Version 2)

Introduction

The adoption of Assembly Bill 617 (AB 617) established collaborative programs to reduce community exposure to air pollutants in neighborhoods most impacted by air pollution. Air District staff have been working closely with the California Air Resources Board (CARB), other state agencies, local air districts, community groups, community members, environmental organizations, regulated industries, and other key stakeholders to reduce harmful air pollutants in Bay Area communities.

As part of these programs, Air Quality Modeling and Analysis Section staff have been estimating concentrations of directly emitted fine particulate matter ($PM_{2.5}$) from major industrial facilities in the Bay Area. This information is being used to estimate the contributions of emitted $PM_{2.5}$ to ambient levels, assess the adverse impacts of those contributions on human health and welfare, and quantify the benefits of reducing those impacts through emission controls.

Atmospheric $PM_{2.5}$ is a complex mixture of suspended particles and liquid droplets having aerodynamic diameters of 2.5 µm or less. These particles are small enough to be inhaled into the lungs and thereby enter the bloodstream. Numerous studies have reported that $PM_{2.5}$ is deleterious to the respiratory and cardiovascular systems. In the lungs, $PM_{2.5}$ aggravates asthma, bronchitis, and other respiratory problems, leading to increased hospital admissions. In the heart and vascular system, $PM_{2.5}$ is associated with chronic hardening of the arteries (atherosclerosis) and triggering of heart attacks (acute myocardial infarctions). Decreased life expectancy, potentially on the order of years, has been documented.

The United States Environmental Protection Agency (US EPA) has developed the Environmental Benefits Mapping and Analysis Program – Community Edition (BenMAP–CE) to estimate and quantify conventional valuations of health impacts associated with changes in ambient pollutant levels (US EPA, 2018). Staff of the Air Quality Modeling and Analysis Section have been applying this program to estimate adverse impacts of $PM_{2.5}$ on Bay Area residents (Tanrikulu, et al., 2011). This program is also being used to assess the impacts of $PM_{2.5}$ emitted from major industrial facilities in the Bay Area.

The impacts of $PM_{2.5}$ from PBF Martinez refinery emissions were analyzed for this report. The impacts of emissions from Chevron Richmond refinery are documented in Fang et al. (2021). The impacts of emissions from other major facilities will be reported separately.

Materials and methods

2.1 US EPA's BenMAP–CE computer program

In this study, BenMAP–Community Edition (BenMAP–CE), version 1.5, was used (https://www.epa.gov/benmap). This program was designed to estimate changes in human health due to changes in ambient air quality for specific populations and to estimate conventional valuations of these impacts (in US dollars).

The valuation process takes into account both the direct costs of illnesses such as actual medical costs and lost worker hours and indirect costs reflecting *willingness to pay* to avoid pain and suffering as well as premature death. The direct costs alone may substantially underestimate the total valuation assigned to reductions in these outcomes. For pollutants capable of causing death, such as $PM_{2.5}$, the mortality-based component tends to far outweigh the morbidity-based component. The calculations implemented by BenMAP–CE include assessing the change in population exposure, using health impact functions to estimate the incremental change in selected human health outcomes based on the exposure difference, and evaluating the range of monetary valuations associated with these outcomes.

Epidemiological data are used to develop concentration–response functions, which BenMAP–CE uses to quantify the linkages between pollutant exposures and adverse health outcomes. These functions are typically stratified by population subgroups (e.g., age groups) and account for the effects associated with a specific duration and degree of pollutant exposure. Population data and pollutant concentration data input to BenMAP–CE must be prepared in a manner consistent with these concentration–response functions. Epidemiological data linking $PM_{2.5}$ exposure and mortality are typically stratified by age group (e.g., infants, 18 years of age and older, etc.) and reflect an annual averaging period.

The BenMAP–CE program overlays population data onto changes in ambient pollutant concentrations to calculate spatially resolved impacts associated with pollutant exposure. Pollutant concentration data are taken from air quality model simulations or observations.

The study described in this report was the first of its kind to use high-resolution simulated pollutant fields to evaluate $PM_{2.5}$ health impacts over the Bay Area. High-resolution simulations reproduced the sharp spatial gradients in pollutant concentrations that result in significant neighborhood-to-neighborhood differences in human exposures.

An alternative approach would be to use air monitoring data. This approach would require interpolating pollutant levels from a network of monitors to construct levels over unmonitored neighborhoods. Since air monitoring data include concentrations from emissions of all sources, this approach is not applicable to our project that assesses health impacts of emissions from a specific source or proposed or adopted emissions control.

Applications of BenMAP–CE require the development of two sets of inputs: ambient $PM_{2.5}$ concentrations and population data. The preparation of these datasets for this study is discussed below.

2.2 Preparation of $PM_{2.5}$ concentrations

The California Puff (CALPUFF) model was used for estimating ambient $PM_{2.5}$ concentrations from Chevron Richmond refinery emissions (Koo et al., 2021a) and from PBF Martinez refinery emissions (Koo et al., 2021b). CALPUFF estimates pollutant concentrations at predefined receptor locations. Two receptor domains were established for the simulations. One covered the entire Bay Area at 1-km grid resolution, and the other covered a smaller area at 100-m grid resolution.

Results from the larger domain encompassing emissions from both Chevron Richmond and the PBF Martinez refineries were used to establish a "study area" approximating a "refinery corridor." This study area, consisting of the union of Census blocks for which an average modeled contribution (from both facilities combined) was determined to meet or exceed 0.1 $\mu g/m^3$ $PM_{2.5}$, was used to scope the residential population for which impacts were assessed.

CALPUFF was applied for three years (2016, 2017, and 2018) using year-specific meteorology and the same base-year (2018) emission estimates that included all inventoried $PM_{2.5}$ emissions from the refineries. The average results from the three annual simulations were used for health impacts analyses to minimize the effects of year-to-year variability in meteorology on ambient $PM_{2.5}$ levels. The average concentrations from the baseline simulation of the PBF Martinez refinery are shown in Figure 2.1.

CALPUFF was also applied for two additional simulations for the same years and the resulting concentrations were averaged in the same manner as described above: (1) a simulation with emissions only from the refinery's fluidized catalytic cracking unit (FCCU) and (2) a simulation with emissions only from the refinery's FCCU controlled with an assumed wet gas scrubber (WGS). Air District staff believes that the more stringent 0.010 gr/dscf standard under Control Scenario B could only be met with a wet gas scrubber.

Analyses were also conducted for an assumed emissions rate corresponding to the 0.020 gr/dscf standard under Control Scenario A. Air District staff assumes stack release parameters would remain consistent with the current refinery configuration. For this scenario, concentrations estimated with the FCCU emissions only was uniformly reduced 55%, and the resulting concentrations were subtracted from the base simulation. This percent reduction is consistent with the 0.020 gr/dscf standard. Figure 2.2a shows reductions in $PM_{2.5}$ concentrations due to the 0.020 gr/dscf standard (scenario A). Figure 2.2b shows reductions in $PM_{2.5}$ concentrations due to the 0.010 gr/dscf standard (assuming WGS control) from the PBF Martinez refinery (scenario B).

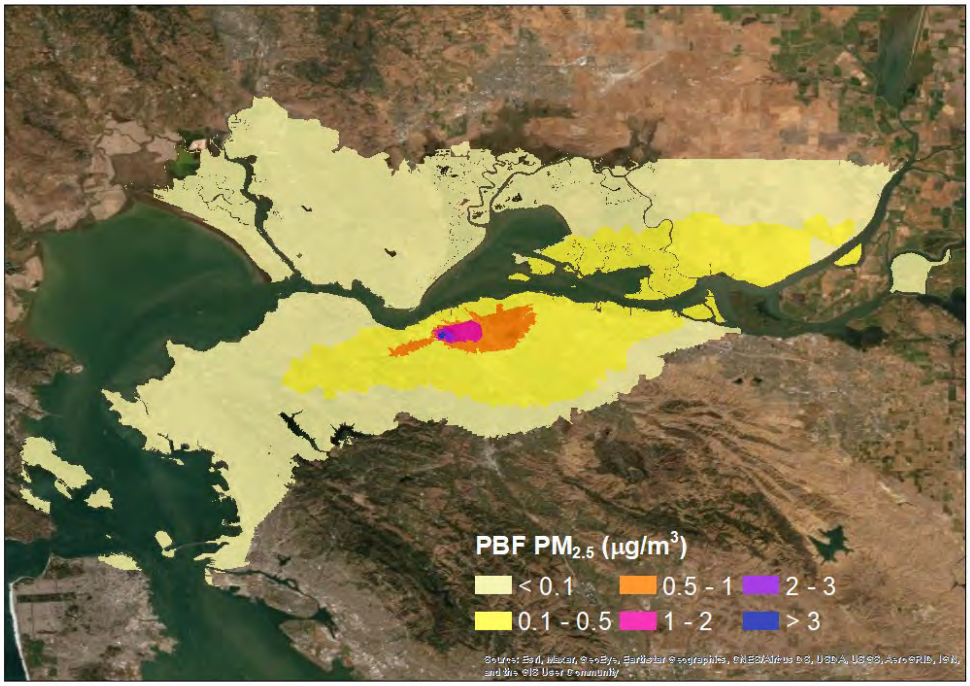

Figure 2.1: Average $PM_{2.5}$ concentrations from the baseline scenario for the PBF Martinez refinery.

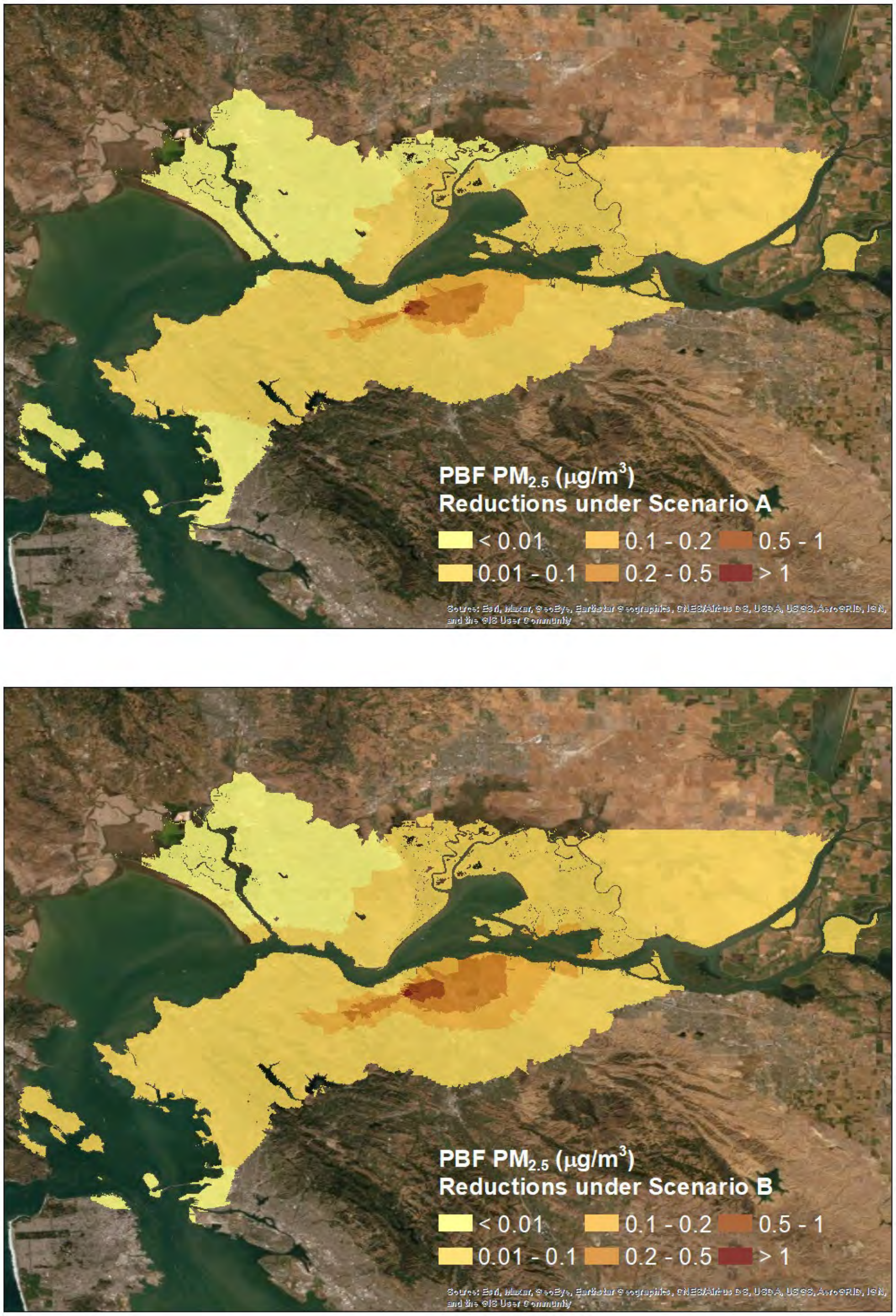

Figure 2.2: (a) Reductions in average $PM_{2.5}$ concentrations due to 0.020 gr/dscf standard (upper panel, Control Scenario A); (b) reductions in average $PM_{2.5}$ concentrations due to 0.010 gr/dscf standard (lower panel, Control Scenario B).

BenMAP–CE requires two sets of ambient concentrations to estimate health impacts. These are called base and control cases. CALPUFF simulations were designed to estimate: (1) the overall health impacts of $PM_{2.5}$ emitted from the PBF Martinez refinery, and (2) the benefits of reducing FCCU emissions under Control Scenario A and Control Scenario B. For estimating overall health impacts, the base case was the three-year average simulated $PM_{2.5}$ concentrations from all PBF emissions, while the control case was simply an assumed concentration field with zero $PM_{2.5}$ (i.e., no emissions from PBF) for comparison; the difference between these two cases provided a representation of the $PM_{2.5}$ contribution associated with total PBF emissions.

For estimating the benefits of reducing FCCU emissions, the base case was the three-year average simulated $PM_{2.5}$ concentrations from uncontrolled FCCU emissions, while the control cases were the $PM_{2.5}$ concentration field resulting from the Control Scenario A and Control Scenario B emissions.

BenMAP–CE provides population data from the 2010 Census at both the Census block and Census tract levels. Block-average $PM_{2.5}$ contributions were assigned to each Census block in the study area. Figure 2.3 illustrates the set of such blocks. For details of the calculation of block averages, see Holstius and Martien, 2021.

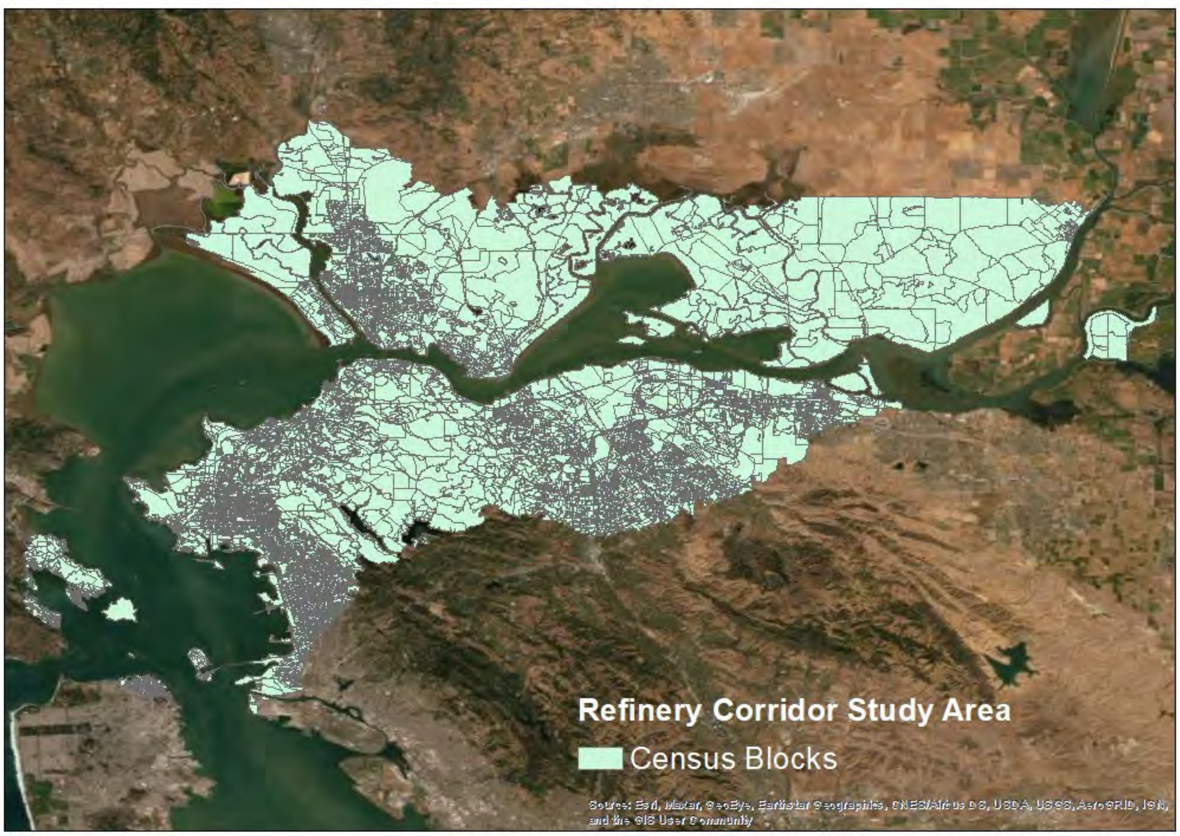

Figure 2.3: Map of the study area and all Census blocks included in the BenMAP–CE analysis.

2.3 Preparation of population data

BenMAP–CE requires population data to be grouped in a specific way to apply the available health impact functions. The developers of BenMAP–CE had already grouped the US Census Bureau's population data for this purpose for 2010, a year the most comprehensive census was conducted (Table 2.1). We projected the 2010 data to 2020 using an available module in BenMAP-CE, Figure 2.4.

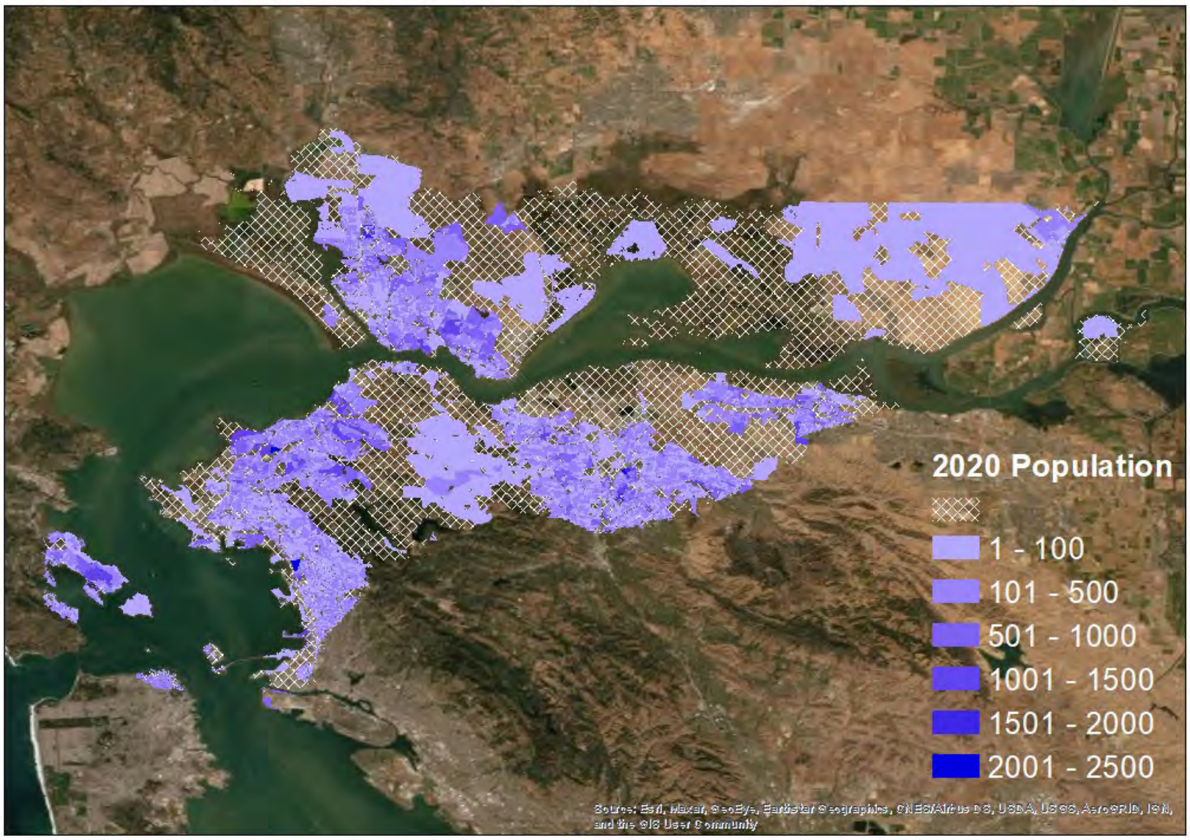

Figure 2.4: Projected 2020 population obtained by applying PopGrid to 2010 Census data.

As can be seen from Table 2.1, there were a total of 304 population groups for which $PM_{2.5}$ health impacts could be estimated. They comprised nineteen age, four race, two ethnic, and male and female groups (details of how these groups were established are provided in Appendix J of EPA 2018). BenMAP's racial classification schema is identical to that of the Center for Disease Control (CDC), from which BenMAP obtains baseline health data. CDC's schema is aligned with the US Census 2010 schema, except that multi-racial ("2 or more races," etc.) as well as "other race" responses are reclassified into one of these four "single-race" bins based on auxiliary data.[1] Thus, multiracial and other classifications have not been dropped; they have been reclassified into one of these four categories.

Table 2.1: BenMAP–CE population groupings.

Age	Race	Ethnicity	Sex
<1, 1–4, 5–9, 10–14, 15–19, 20–24, 25–29, 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, 80–84, 85+	White African American Asian American Indian	Hispanic Non-Hispanic	Male Female

Application of BenMAP–CE

BenMAP–CE was applied for three different scenarios at the Census block level across the study area, as shown in Table 3.1. The first scenario, the baseline scenario, assessed the total impacts of $PM_{2.5}$ emitted from all modeled sources at the PBF Martinez refinery. Scenarios A and B assessed reductions in these impacts due to achieving PM_{10} standards of 0.020 gr/dscf and 0.010 gr/dscf at the FCCU, respectively.

Table 3.1: BenMAP–CE application scenarios.

Scenario	Domain	Base Case	Control Case
Baseline	Study area (Census block level)	$PM_{2.5}$ emissions from all PBF sources	All $PM_{2.5}$ concentrations set to zero (no emissions from PBF)
A	Study area (Census block level)	$PM_{2.5}$ emissions from all PBF sources	$PM_{2.5}$ emissions from all PBF sources, but with FCCU emissions controlled to 0.020 gr/dscf standard
B	Study area (Census block level)	$PM_{2.5}$ emissions from all PBF sources	$PM_{2.5}$ emissions from all PBF sources, but with FCCU emissions controlled to 0.010 gr/dscf standard

BenMAP–CE was run using the same set of health impact functions used by the US EPA to assess $PM_{2.5}$ impacts in the United States, except for functions related to premature mortality. For the premature mortality category, we added three health impact functions to the EPA's set to ensure that the premature mortality endpoint was evaluated rigorously. Two of the added functions are from Jerrett et al., 2013 and are based on California-wide and nationwide analyses of a 1980–2000 cohort. The third added function is from Vodonos et al., 2018, which

[1] This practice, termed "race bridging," is a convention followed by the CDC to support long-term trend analyses.

itself is a meta-analysis summarizing 53 single studies (including the three other studies that we included), 17 of which have been published since 2015.

Table 3.2 summarizes the health impact functions used in BenMAP–CE and also provides information on the health endpoints associated with each study, age range, and baseline health data used.

Table 3.2: Health endpoint, studies developed health impacts functions and epidemiological data used.

Health Endpoint	Studies Developed Health Impacts Functions	Study Population	Baseline Health Data as Named in BenMAP–CE
Cardiovascular			
Nonfatal heart attacks	Peters et al. (2001)	18+ years	Other incidence (2014)
	Pooled estimate: -Pope et al. (2006) -Sullivan et al. (2005) -Zanobetti et al. (2009) -Zanobetti and Schwartz (2006)	18+ years	Other incidence (2014)
Hospital admission, cardiovascular	Pooled estimate: -Zanobetti et al. (2009) -Peng et al. (2009) -Peng et al. (2008) -Bell et al. (2008)	64+ years	Other incidence (2014)
	Moolgavkar (2000)	18–64 years	Other incidence (2014)
Lost Work			
Work loss days	Ostro (1987)	18–65 years	Other incidence (2000)
Restricted Activity			
Minor restricted activity days	Ostro and Rothschild (1989)	18–65 years	Literature data
Asthma			
Asthma exacerbations	Pooled estimate: -Ostro et al. (2001) -Mar et al. (2004)	6–18 years	Prevalence (2008)

Health Endpoint	Studies Developed Health Impacts Functions	Study Population	Baseline Health Data as Named in BenMAP–CE
Asthma-related ER visits	Pooled estimate: -Mar et al. (2010) -Slaughter et al. (2005) -Glad et al. (2012)	All ages	Other incidence (2014)
Hospital admission, asthma	Pooled estimate: -Babin et al. (2007) -Sheppard (2003)	0–17 years	Other incidence (2014)
Respiratory illness			
Upper respiratory symptoms	Pope et al. (1991)	Asthmatics, 9–11 years	Prevalence (2008)
Lower respiratory symptoms	Schwartz and Neas (2000)	7–14 years	Literature data
Acute bronchitis	Dockery et al. (1996)	8–12 years	Other incidence (2000)
Hospital admission, chronic lung disease	Moolgavkar (2000)	18–64 years	Other incidence (2014)
Mortality			
Mortality, all-cause	Krewski et al. (2009) Lepeule et al. (2012) Woodruff et al. (1997)	30+ years 25+ years Infant (<1 year)	Mortality incidence (2020)
Mortality, all-cause (added to BenMAP–CE)	Jerrett et al. (2013) for CA Jerrett et al. (2013) for US Vodonos et al. (2018)	30+ years 30+ years All ages	Mortality incidence (2020)

Results

Results obtained from BenMAP–CE are tabulated in Table 4.1 using the US EPA's pooling method. This method allows users to summarize health and monetary impacts from changes in $PM_{2.5}$ concentrations. BenMAP–CE results showed that $PM_{2.5}$ emissions from the PBF Martinez refinery result in 2.8 to 6.3 premature deaths per year, valued at 28.8 to 64.9 million US dollars. Achievement of the standards under Control Scenario A and Control Scenario B at the refinery's FCCU were estimated to reduce annual excess deaths by 35% and 50%, respectively, and result in benefits valued at 10.1 to 22.7 and 14.4 to 32.4 million dollars per year, respectively. The range in the valuations shown, for both the baseline and the control benefits, is mostly attributable to the range in mortality impacts from the different health impact functions applied.

Table 4.1: Summary of health and monetary impacts of $PM_{2.5}$ from PBF Martinez refinery emissions and percent change of valuation for FCCU emissions under Control Scenario A and Control Scenario B.

Baseline Health Impact[1] of PBF Martinez Refinery (Annual)		Valuation[2] (Annual)	Reduction under Control Scenario A	Reduction under Control Scenario B
Cardiovascular	0.3–2.4 heart attacks	$37 k–350 k	-35%	-50%
	0.6 hospital admissions	$26 k	-35%	-50%
Restricted Activity	2,700 days	$200 k	-35%	-50%
Lost Work	460 days	$100 k	-35%	-50%
Asthma	110 exacerbations[3]	$7 k	-35%	-50%
	2 emergency room visits	$1 k	-35%	-50%
	<0.1 hospital admissions	$1 k	-35%	-50%
Respiratory Illness[4]	80 upper tract[3]	$3 k	-35%	-50%
	50 lower tract[3]	$1 k	-35%	-50%
	4 bronchitis[3]	$2 k	-35%	-50%
	0.1 chronic lung disease	$3 k	-35%	-50%
Mortality[5]	2.8–6.3 deaths	$28.8 M–64.9 M	-35%	-50%
			$10.1 M to $22.7 M/yr	**$14.4 M to $32.4 M/yr**

[1] On the study population (about 1 million people)
[2] Conventional US EPA valuations, in 2015 US dollars
[3] Subset of pediatric (≤ 18 years)
[4] Other than asthma
[5] Including infant mortality
k, thousand; M, million.

Note that valued benefits shown in Table 4.1 represent US EPA's national average valuation, and were not modified specifically for the Bay Area.

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Appendix A.4:

Modeling Fine Particulate Matter Emissions from the Chevron Richmond Refinery: An Air Quality Analysis (Version 2)

Version 2 promoted to final from interim draft.

Updates since version 1: Appendix A.4 reordered with Appendix A. Text was added to describe adjustments made to 2018 baseline emissions to represent some facility changes that have occurred since 2018.

Bay Area Air Quality Management District
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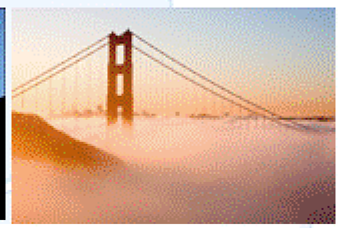
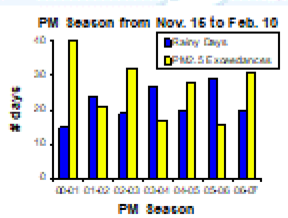
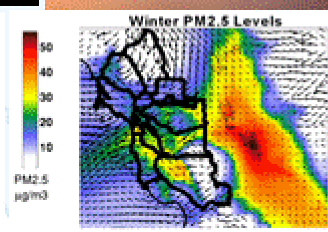
Air Quality Modeling and Analysis Section Publication No. 202103-020-PM

Modeling Fine Particulate Matter Emissions From the Chevron Richmond Refinery: An Air Quality Analysis (Version 2)

March 2021







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Executive Summary

Introduction

Staff at the Bay Area Air Quality Management District (Air District or BAAQMD) are in the process of estimating contributions of directly emitted fine particulate matter ($PM_{2.5}$) from major industrial facilities in the Bay Area to ambient $PM_{2.5}$ levels. This report presents results from the Chevron refinery in Richmond, California. Results from other facilities as well as from the analysis of human exposure to estimated $PM_{2.5}$ levels will be reported as they become available. The purpose of this effort is to provide technical information to supplement the Air District's rule development efforts and to support the Air District's assessments related to the implementation of Assembly Bill 617 (AB 617).

The California Puff (CALPUFF) model will be used for estimating ambient $PM_{2.5}$ levels contributed by major Bay Area facilities. Emissions from each major facility will be separately simulated using CALPUFF. Two sets of receptor domains will be established. One will cover the entire Bay Area at 1-km grid resolution, and the other will cover areas with simulated $PM_{2.5}$ concentrations above 0.1 $\mu g/m^3$ at 100-m grid resolution.

Baseline emissions used for modeling include contributions representative of 2018, the most recent year that emissions have been checked and finalized by the Air District. However, adjustments were made to reflect reductions in non-FCCU sources that have occurred since 2018, due to Chevron's Modernization Project (City of Richmond, 2015). Notably, emissions from old hydrogen plant furnaces were omitted from the modeling to reflect more current conditions. Facility-total adjusted annual $PM_{2.5}$ baseline emissions match more recent draft emissions (2019) that include Modernization Project changes to within about 5 tons.

CALPUFF will be applied for three years (2016, 2017, and 2018) using year-specific meteorology and the same baseline (adjusted 2018) emission estimates. Average results from the three annual simulations will be used for analyses to minimize the impact of year-to-year variability in meteorology on ambient $PM_{2.5}$ levels.

CALPUFF requires an emissions input file that includes detailed information for each modeled source, including source ID number, location coordinates, base elevation, stack height, stack diameter, gas exit velocity, gas exit temperature, and emission rate. There were 119 release points identified for the $PM_{2.5}$ emissions at the Chevron refinery and an estimated total (adjusted 2018) of 473 tons of $PM_{2.5}$ emitted annually. The single largest source, the fluid catalytic cracking unit (FCCU), is responsible for almost half (48%) of the annual $PM_{2.5}$ emissions.

It should be noted that all emissions and stack parameter data represent the best available information at the time the modeling was conducted. Prior to modeling, quality control (QC) checks were performed on the stack-level data. For example, source locations were plotted and reviewed. In addition, minimum and maximum values for each stack parameter were identified to ensure that all values fell within reasonable bounds.

Meteorological inputs to CALPUFF were prepared using the Weather Research and Forecasting (WRF) model. The WRF model was tested using available options for physics and dynamics, as well as the datasets used to initialize and drive the model. Results of each test were evaluated, and the best performing set of options was selected for final modeling.

Results

Simulation results are presented for three different emissions scenarios: emissions from (1) all point sources, (2) FCCU only, and (3) FCCU with an assumed wet gas scrubber. Key findings are tabulated, illustrated, and discussed below.

Simulations with Emissions from All Sources

Figure ES.1 shows the three-year (2016–2018) average CALPUFF-simulated $PM_{2.5}$ concentrations for the 100-m receptor domain. Estimated concentrations within the Chevron facility fence line and concentrations below 0.1 µg/m^3 are not shown.

CALPUFF estimates concentrations at receptor points located at the center of each 100 x 100 m grid cell. For mapping purposes, each grid cell is color coded based on the concentration value at its center. An interval of 0.5 µg/m^3 was selected for color coding (except for concentrations between 0.1 µg/m^3 and 0.5 µg/m^3).

As can be seen in Figure ES.1a, the lowest concentration bin (0.1 µg/m^3 to 0.5 µg/m^3) extends from near Treasure Island in the south to American Canyon in the north and from Tiburon in the west to Vallejo in the east. The emissions plume has an elongated shape in the southwesterly and northeasterly directions from Richmond, consistent with the predominant winter and summer wind patterns there, respectively.

The area with concentrations above 0.5 µg/m^3 is much smaller than the area covered by the lowest concentration bin, as described above. These higher concentrations are mostly confined to the area around the Chevron facility and extend toward the northeast of the facility.

To better visualize the high-concentration areas, a zoomed-in map of the 100-m receptor domain was created (Figure ES.1b). As shown in this figure, an area with concentrations between 0.5 µg/m^3 and 1.0 µg/m^3 extends from downtown Richmond in the south to a location over the bay in the north and from Point Molate in the west to near downtown Pinole in the east. Concentrations below 1.0 µg/m^3 extend to residential areas on the east, south, and west sides of the Chevron facility.

Concentrations above 1.0 µg/m^3 primarily lie on the north side of the facility over the bay; however, this area extends to the shoreline toward the northeast of the facility. In addition, a sharp concentration gradient is apparent near the facility fence line. The maximum concentration (5.9 µg/m^3) is located just outside the facility fence line.

For reference, in recent years, the observed annual average $PM_{2.5}$ level at the Air District's nearby San Pablo regulatory monitoring site is about 10 µg/m^3. If the contribution of wildfire emissions is excluded, it would be about 9 µg/m^3. Almost half a million people (449,000) reside within the area where concentrations from the Chevron refinery are above 0.1 µg/m^3.

Simulations with FCCU Emissions

CALPUFF was also run with emissions from only the FCCU for two scenarios: one with the baseline FCCU emissions and the other with reduced FCCU emissions (and altered stack parameters) consistent with the installation of a wet gas scrubber (WGS). The resulting three-year average $PM_{2.5}$ concentrations are shown in Figure ES.2 (FCCU without WGS) and Figure ES.3 (FCCU with WGS installed). Again, concentrations within the facility fence line and below 0.1 µg/m^3 are not shown. An interval of 0.1 µg/m^3 was selected for color coding the concentration values at grid cells.

Emissions from this source are mainly transported to the northeast of the facility, consistent with the predominant summer wind pattern. An area with concentrations between 0.1 µg/m^3 and 0.2 µg/m^3 passes Pinole Point but does not reach Vallejo. This area also extends towards the City of Richmond. The number of sampling receptors (100 m grid) with three-year average concentrations above 0.1 µg/m^3 was reduced from 66,659 (all-source simulation) to 8,499 (FCCU-only simulation), i.e., an 87% reduction. The maximum three-year average concentration from this source is 0.97 µg/m^3, or about 16% of the maximum concentration from the all-source simulation. Emissions from the FCCU, however, account for about 48% of total $PM_{2.5}$ emissions from the facility. This discrepancy is likely due to release characteristics for this source, which has a 46-m tall stack and a gas exit temperature of 505°K. These stack parameters indicate that under most atmospheric conditions, emissions from this source may remain in aloft layers for some distance downwind compared with emissions from other sources.

Installation of a WGS further reduces the number of receptors with three-year average concentrations above 0.1 µg/m^3 to 1,250 (an 85% reduction from the baseline FCCU emission scenario) and reduces the maximum three-year average concentration to 0.50 µg/m^3 (52% of the maximum concentration from the baseline FCCU emission scenario). This reduction in the maximum concentration is somewhat smaller than the emission reduction by a WGS (65%).

Table ES.1 shows the key findings of simulations with the three sets of emissions.

Table ES.1: Key findings of simulations with emissions from all point sources, FCCU only, and FCCU with assumed WGS. Results shown are for the 100-m receptor domain.

	Annual $PM_{2.5}$ emissions (tons/year)	Maximum simulated concentrations (µg/m^3)	Number of sampling receptors with concentrations above 0.1 µg/m^3
All point sources	472.96	5.9	66,659
FCCU only	228.61	0.97	8,499
FCCU with assumed WGS	80.01	0.50	1,250

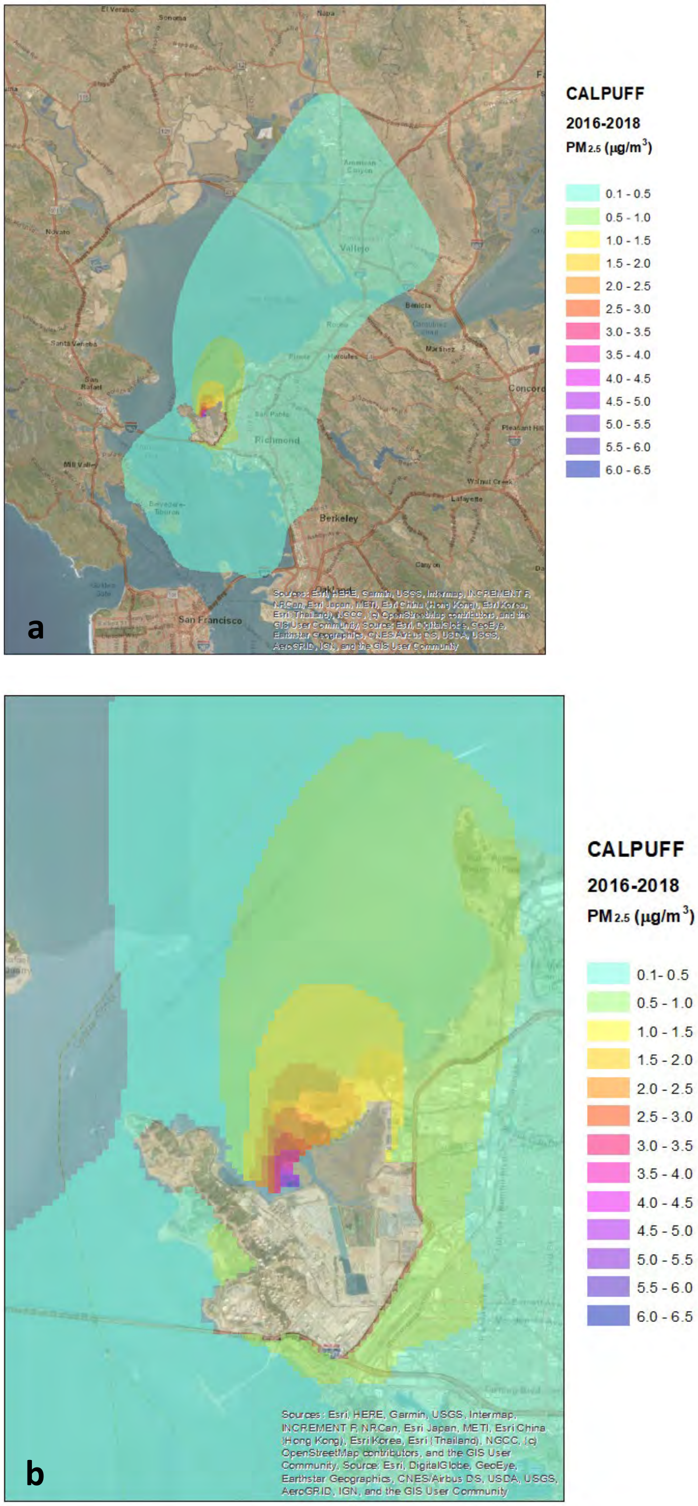

Figure ES.1: Three-year (2016–2018) average CALPUFF-simulated $PM_{2.5}$ concentrations for (a) the 100-m receptor domain, and (b) a zoomed-in area of high concentrations. Emissions from all (119) point sources are included in these simulations. Concentrations inside the Chevron fence line and that are below 0.1 µg/m^3 are not shown.

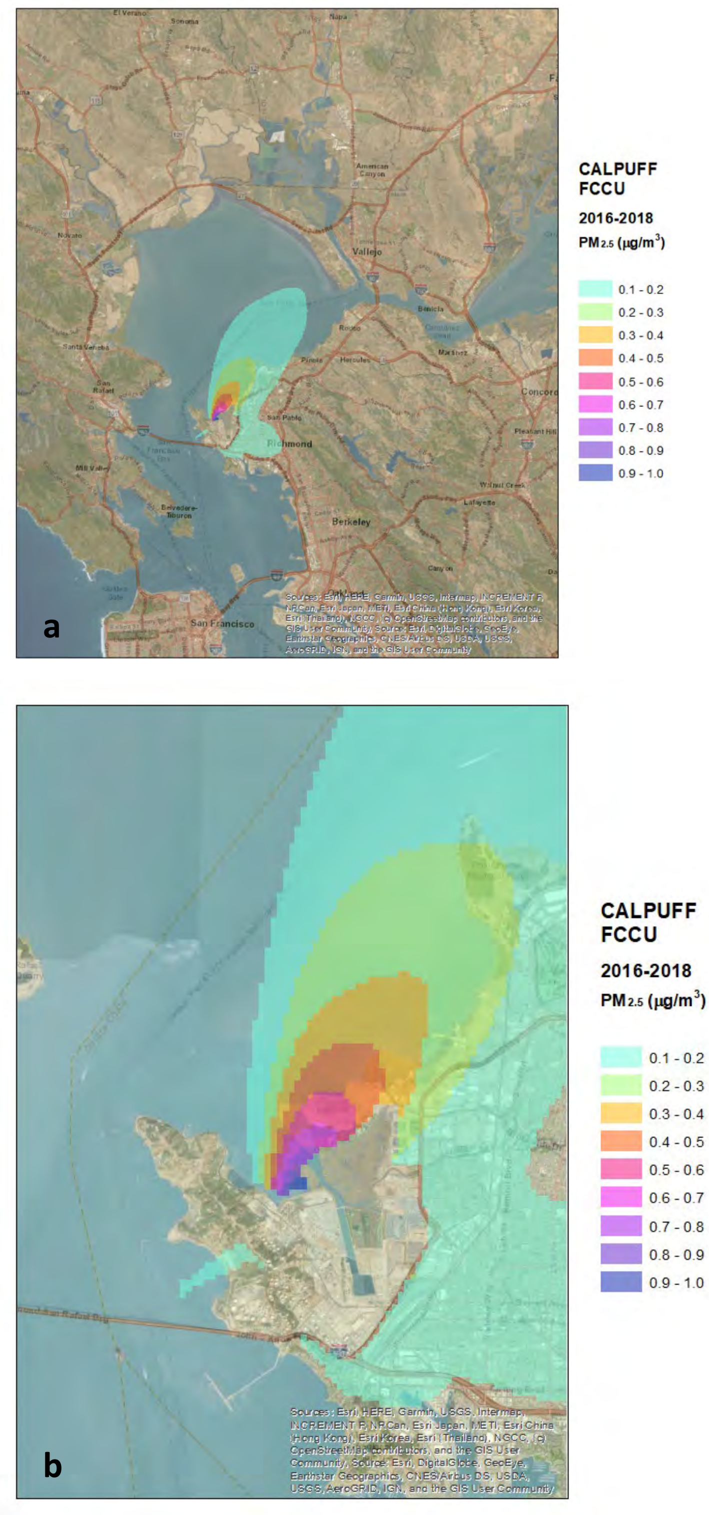

Figure ES.2: Three-year (2016–2018) average CALPUFF-simulated $PM_{2.5}$ concentrations for: (a) the 100-m receptor domain, and (b) a zoomed-in area of high concentrations. Emissions from the FCCU only (without a WGS) are included in these simulations. Concentrations inside the Chevron fence line and that are below 0.1 µg/m^3 are not shown.

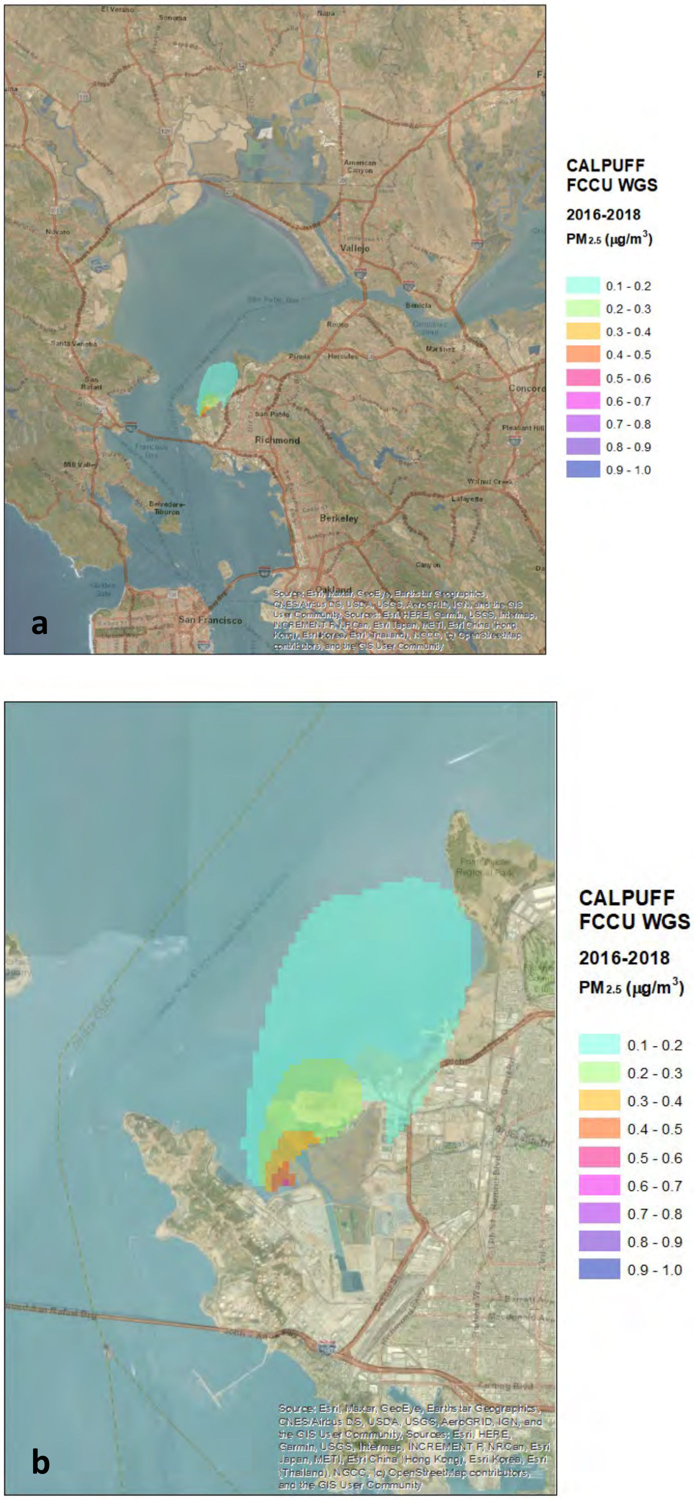

Figure ES.3: Three-year (2016–2018) average CALPUFF-simulated $PM_{2.5}$ concentrations for: (a) the 100-m receptor domain, and (b) a zoomed-in area of high concentrations. Emissions from the FCCU only (with an assumed WGS) are included in these simulations. Concentrations inside the Chevron fence line and that are below 0.1 µg/m^3 are not shown.

List of Acronyms

AB 617	Assembly Bill 617
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
ASPEN	Assessment System for Population Exposure Nationwide (model)
BAAQMD	Bay Area Air Quality Management District
BenMAP-CE	Benefits Mapping and Analysis Program-Community Edition
CALPUFF	California Puff (model)
CAMx	Comprehensive Air Quality Model with Extensions
CARB	California Air Resources Board
CFR	Code of Federal Regulations
CMAQ	Community Multiscale Air Quality (model)
EPA	Environmental Protection Agency
FCCU	Fluid Catalytic Cracking Unit
FDDA	Four-Dimensional Data Assimilation
FLM	Federal Land Manager
GMT	Greenwich Mean Time
IOA	Index of Agreement
ISCST3	Industrial Source Complex Short Term 3 (model)
MMIF	Mesoscale Model Interface
PDF	Probability Distribution Function
PG	Pasquill–Gifford
$PM_{2.5}$	Particulate Matter 2.5 micrometers or less in diameter
PST	Pacific Standard Time
QA	Quality Assurance
QC	Quality Control
RMSE	Root Mean Square Error
SCICHEM	Second-order Closure Integrated Puff with Chemistry (model)
SRDT	Solar Radiation/Delta-T
TIBL	Thermal Internal Boundary Layer
UTM-TOX	Urban Airshed Model for Toxics
WGS	Wet Gas Scrubber
WOEIP	West Oakland Environmental Indicators Project
WRF	Weather Research and Forecasting (model)

Modeling Fine Particulate Matter Emissions From the Chevron Richmond Refinery: An Air Quality Analysis (Version 2)

Introduction

1.1 Background

The adoption of Assembly Bill 617 (AB 617) established collaborative programs to reduce community exposure to air pollutants in neighborhoods most impacted by air pollution. Air District staff have been working closely with the California Air Resources Board (CARB), other state agencies, local air districts, community groups, community members, environmental organizations, regulated industries, and other key stakeholders to reduce harmful air pollutants in Bay Area communities.

As part of these programs, staff at the Bay Area Air Quality Management District (Air District or BAAQMD) plan to estimate contributions of directly emitted fine particulate matter ($PM_{2.5}$) from major industrial facilities in the Bay Area to ambient $PM_{2.5}$ levels. Staff will then analyze human exposure to resulting $PM_{2.5}$ levels. The California Puff (CALPUFF) model (Version 6.42; Exponent, 2011) will be used for estimating ambient $PM_{2.5}$ levels contributed by major facilities.

Emissions from each major facility will be separately simulated using CALPUFF. Two sets of receptor domains will be established. One will cover the entire Bay Area at 1-km grid resolution and the other will cover areas with concentrations above 0.1 µg/m^3 at 100-m grid resolution.

CALPUFF will be applied for three years (2016, 2017, and 2018) using year-specific meteorology and the same baseline (adjusted 2018) emission estimates. Average results from the three annual simulations will be used for analyses to minimize the impact of year-to-year variability in meteorology on ambient $PM_{2.5}$ levels. The model estimates hourly concentrations at each receptor location, and these hourly values are then aggregated into daily, monthly, and annual averages. Concentrations estimated for these averaging periods will be analyzed for the purpose of model evaluation; however, only annual and three-year average concentrations will be presented in modeling reports for each facility.

CALPUFF is an advanced puff model originally developed for CARB (under the management of Saffet Tanrikulu, currently a District manager) to simulate pollutants emitted from major facilities and roadways in a complex terrain environment. CALPUFF was adopted by the U.S. Environmental Protection Agency (EPA) in 2003 as a “preferred” dispersion model, becoming one of the most widely used models for studying pollutant dispersion and transport in the U.S. and worldwide. However, in 2017, CALPUFF was removed from the U.S. EPA’s “preferred model” list due to concerns about its ability to handle long-range pollutant transport. Because the main goal of our project is to assess impacts of pollutants relatively near their sources, the U.S. EPA's concern is not relevant to our application of the model.

This report will present results from the application of CALPUFF to emissions from the Chevron refinery in Richmond. CALPUFF applications for other Bay Area refineries and the Lehigh Cement factory are under way, and results from those simulations will be reported in subsequent documents.

1.2 Model Selection and Modeling Strategy

Air District staff have applied the U.S. EPA's Community Multiscale Air Quality (CMAQ) model (EPA, 1999) to estimate regional $PM_{2.5}$ and air toxics concentrations in the Bay Area (Tanrikulu et al., 2019). Because of limitations in its internal parameterization, this model is typically applied at 1-km or coarser grid resolutions. CMAQ has a plume-in-grid module for handling diffusion and dispersion of pollutants emitted from large point sources at subgrid scales. This plume-in-grid module employs a modified version of the Second-order Closure Integrated Puff with Chemistry (SCICHEM) model (Karamchandani et al., 2014).

One advantage of applying CMAQ with the plume-in-grid module is the ability to simultaneously simulate $PM_{2.5}$ at regular grid resolutions as well as subgrid resolutions. The plume-in-grid module in CMAQ was tested for the Bay Area modeling domain at 1-km grid resolution but failed to complete the test due to prohibitively large computational cost (Tanrikulu et al., 2019). Troubleshooting the model was not feasible within this project schedule; however, as a corroborative analysis, we conducted simulations with the stand-alone version of SCICHEM (Version 3.2.2; EPRI, 2019) and compared its results against results obtained from CALPUFF (Koo et al., 2020).

Air District staff have applied another dispersion model (AERMOD) for simulating $PM_{2.5}$ emissions from local sources to assess their impacts on community-scale $PM_{2.5}$ levels. Most recently, AERMOD was applied for a wide variety of emission sources in West Oakland (BAAQMD and WOEIP, 2019). It is also used by the District to evaluate permit applications. AERMOD utilizes meteorological information, such as wind speed and direction, at source locations only. This is a significant shortcoming of the model when it is used to simulate elevated point source emissions that can travel to downwind locations where near-source meteorological information is no longer representative.

The CALPUFF model is specifically designed to utilize meteorological information over the entire area where plume is expected to travel. Therefore, CALPUFF is more suitable for simulating $PM_{2.5}$ from the major point sources identified for this project.

CALPUFF has been applied in the Bay Area by the Air District as well as CARB to support several prior projects. In 2008, CARB, in collaboration with the Air District, conducted a health risk assessment study to evaluate the potential public health impacts of diesel $PM_{2.5}$ emissions in West Oakland (CARB, 2008). To estimate ambient $PM_{2.5}$ levels, the project team considered several air dispersion models, such as ISCST3, AERMOD, ASPEN, CALPUFF, UTM-TOX, and CAMx, but selected CALPUFF because of its ability to handle complex terrain impacts and better treat various emission sources at fine scales. In 2017, CALPUFF was used for a collaborative demonstration project by the Air District and U.S. EPA that assessed the impact of $PM_{2.5}$ precursor emissions in the Bay Area (BAAQMD, 2017).

CALPUFF can be run with two different domains: (1) a computational domain, and (2) a receptor domain. In the computational domain, the model calculates plume dynamics using input parameters such as emissions, as well as gridded meteorological, land use, and terrain elevation data. In the receptor domain, the model samples estimated concentrations at specified receptor points. Receptor points can be either gridded, where the model samples concentrations at the center of each grid cell or placed at discrete locations specified by the user. In general, gridded receptors are used for large, facility-impacted areas, and discrete receptors are used for sensitive locations such as hospitals, schools, facility fence lines, etc.

As mentioned above, for the purpose of this study, we defined two sets of gridded receptors surrounding the facility and ran the model sequentially for both sets. The first set of receptors covered the entire Bay Area at 1-km grid resolution. A second set of 100-m resolution receptors covered areas with annual average $PM_{2.5}$ levels above 0.1 $\mu g/m^3$, as identified from the 1-km simulation.

1.3 Exposure Analysis

Simulated concentrations show contributions of emissions to ambient $PM_{2.5}$ levels but do not provide information on human exposure to this pollutant. Human exposure to $PM_{2.5}$ is one of the parameters used by air quality planners, the AB 617 technical assessment team, and rule developers in their analyses.

Exposure refers to any contact between an airborne contaminant and a surface of the human body, either outer (such as the skin) or inner (such as the respiratory tract epithelium). Therefore, exposure requires the simultaneous occurrence of two events: a pollutant concentration at a particular place and time, and the presence of a person at that place and time (Ott, 1985).

To estimate population exposure, both concentrations and population data are needed. For this purpose, we will use average simulated $PM_{2.5}$ concentrations for 2016–2018 as the pollutant concentration estimate. Population data will be downloaded from the U.S. Census Bureau for 2010[1] and projected to 2018 using U.S. EPA's Benefits Mapping and Analysis Program-Community Edition (BenMAP-CE Version 1.5; EPA, 2018). Demographic data with socioeconomic information will be used to address disparity issues such as environmental inequality. Results from the exposure analysis will be provided in an accompanying report.

[1] https://www2.census.gov/census_2010/04-Summary_File_1/

1.4 Analysis of Representativeness

$PM_{2.5}$ levels in the Bay Area can vary significantly from year to year due to variable weather patterns and the associated variations in pollutant transport. To account for year-to-year variability in modeled concentrations, we simulated three consecutive years (2016–2018) for this project. This will increase the representativeness of simulated $PM_{2.5}$ levels.

Although we did not conduct a comprehensive meteorological representativeness study, simulating three recent years should increase the representation of meteorology across multiple years and is consistent with EPA's Guideline on Air Quality Models (40 CFR Part 51), where the use of multiple years of meteorological data (up to five) is recommended to ensure worst-case conditions are sufficiently characterized in regulatory modeling applications.

Modeling Methods

2.1 Emissions Inventory Preparation

CALPUFF requires an emissions input file that includes detailed information for each modeled source, including source ID number, location coordinates, base elevation, stack height, stack diameter, gas exit velocity, gas exit temperature, and emissions rate. This section describes the datasets and processes used to develop CALPUFF-ready emissions inputs for Chevron.

To support the implementation of District Regulation 11, Rule 18 (11-18): Reduction of Risk from Air Toxic Emissions at Existing Facilities (BAAQMD, 2018), the District has begun collecting updated stack parameter information from permitted sources in the Bay Area. In addition, updated emission estimates for permitted facilities are being collected and reviewed under Regulation 12, Rule 15 (12-15, Petroleum Refining Emissions Tracking). Using information collected under these regulations, the Air District's Engineering Division developed and shared two spreadsheets to support CALPUFF modeling: one containing annual $PM_{2.5}$ emissions by source, and the other containing stack parameters for each emissions release point in the facility.

Baseline emissions used for modeling include contributions representative of 2018, the most recent year that emissions have been checked and finalized by the Air District. However, adjustments were made to reflect reductions in non-FCCU sources that have occurred since 2018, due to Chevron's Modernization Project (City of Richmond, 2015). Notably, emissions from old hydrogen plant furnaces were omitted from the modeling to reflect more current conditions. Facility-total adjusted annual $PM_{2.5}$ baseline emissions match more recent draft emissions (2019) that include Modernization Project changes to within about 5 tons.

The Air District's Modeling and Analysis Section worked with the Engineering Division to map all $PM_{2.5}$ emissions to the proper release points, which resulted in the identification of 119 unique $PM_{2.5}$ sources at Chevron. It should be noted that all emissions and stack parameter data represent the best available information at the time the modeling was conducted.

Prior to modeling, quality control (QC) checks were performed on the stack-level data. For example, source locations were plotted and reviewed. Also, minimum and maximum values for each stack parameter were identified to make sure that all values fell within reasonable bounds (see Appendix A). After QC checks were complete, emissions and stack parameters for each modeled source were converted to a CALPUFF-ready format using a Python script developed by the Modeling and Analysis Section.

Note that CALPUFF utilizes grid averaged terrain data provided through its meteorological input. The base elevation for each source provided usually does not match grid-averaged terrain elevation, and if these base elevations are used, some short stacks could be represented as emitting at or below ground level. A similar problem arises if the actual elevation of receptors is used rather than grid average terrain elevation. For example, receptors with elevations below the grid average terrain elevation are erroneously treated as underground receptors. To maintain consistency among source, receptor, and terrain elevations in CALPUFF, the base elevations were replaced with grid averaged terrain elevation, and grid averaged terrain elevations were also used for receptors.

Table 2.1.1 provides a summary of $PM_{2.5}$ emissions and stack parameters for the top 20 $PM_{2.5}$ sources at the Chevron refinery. Annual $PM_{2.5}$ emissions from the facility total 473 tons, and the top 20 sources account for over 80% of those emissions. In addition, the single largest source, the fluid catalytic cracking unit (FCCU), is responsible for almost half (48%) of annual $PM_{2.5}$ emissions. This table also includes both the original base elevation data and the values from the Weather Research and Forecasting (WRF) model grid average terrain data that were ultimately used for modeling.

Figure 2.1.1 shows the location of all 119 $PM_{2.5}$ sources modeled in CALPUFF, with the top 20 sources highlighted in red. The location of the FCCU is also identified in this figure.

This study also evaluated the impact of installing a wet gas scrubber (WGS) on the FCCU at Chevron. This type of control equipment not only reduces PM emissions, but also alters the release characteristics of the emissions plume. To develop adjusted emissions and stack parameters for the FCCU with a WGS, staff from the District's Rule Development section reviewed source test data from other refineries to identify facilities with FCCU exhaust flow rates similar to the FCCU exhaust stacks at the Chevron refinery, and which have WGS devices installed on the FCCU. Staff located four facilities with source test data to support this analysis:

- Hovensa Refinery, US Virgin Islands: test data from a US EPA 2011 Refinery Sector Information Collection Request.
- Marathon Refining, Garyville, LA: 2017–2019 source test reports from the Louisiana Department of Environmental Quality's Electronic Document Management System.
- Marathon Refining, Galveston Bay, TX: 2016 source test report from the Texas Commission on Environmental Quality's Central Registry.
- Valero Refinery, Benicia, CA: 2016–2018 source test review memos from BAAQMD.

Stack parameters for WGS-equipped FCCUs at these four facilities are shown in Table 2.1.2, along with average values across all these facilities. These average parameters were used to model FCCU emissions for the WGS control case. In addition, a control factor of 65% was applied to Chevron's baseline FCCU emissions, reducing annual $PM_{2.5}$ emissions from 229 tons to 80 tons. This control factor for $PM_{2.5}$, also provided by the District's Rule Development section, was based on an emission limit of 0.010 grains per dry standard cubic feet (gr/dscf).

Table 2.1.1: Stack parameters and $PM_{2.5}$ emissions for top 20 sources at Chevron.

Source ID	Source Description	Base Elevation (m)	Gridded Terrain Elevation (m)	Stack Height (m)	Stack Diameter (m)	Exit Temperature (°K)	Exit Velocity (m/s)	$PM_{2.5}$ Emissions (tons/year)	Contribution to $PM_{2.5}$ Emissions
4285	FCCU Plant	4.16	37.17	45.70	4.30	505.0	16.40	228.61	48.3%
4352	Cogeneration Unit with HRSG	5.13	19.48	38.10	2.44	449.8	13.40	46.21	9.8%
4350	Cogeneration Unit with HRSG	5.40	19.48	38.10	2.44	449.8	13.40	44.97	9.5%
4229	SRU #3 Train	4.83	15.10	45.72	2.54	588.7	2.31	9.01	1.9%
4227	SRU #1 Train	4.16	15.10	45.72	1.98	588.7	3.02	6.55	1.4%
4072	F-1160 Crude Vacuum	5.16	16.40	47.24	2.90	546.8	7.20	4.24	0.9%
4131	Power Plant Boiler 3	6.88	19.48	38.10	3.14	505.2	7.45	4.11	0.9%
4228	SRU #2 Train	4.16	15.10	45.72	1.98	588.7	3.02	3.99	0.8%
4336	F-1551 Heavy Neutral Hydrocracker	3.00	15.10	59.44	2.34	421.9	2.70	3.87	0.8%
4330	F-1361 Light Neutral Hydrofinisher	2.91	15.10	53.34	2.23	421.9	3.21	3.84	0.8%
4329a	Cooling Tower Richmond Lube Oil Plant	2.79	2.81	20.35	8.53	302.0	1.80	3.84	0.8%
4329b	Cooling Tower Richmond Lube Oil Plant	2.89	2.81	20.35	8.53	302.0	1.80	3.84	0.8%
4333	F-1251 Light Neutral Hydrocracker	5.32	15.10	53.34	2.23	421.9	3.27	3.37	0.7%
4038	F-3550 Rhen Furnace	5.42	16.40	36.58	2.57	492.4	4.76	2.89	0.6%
4155	F-135 Solvent Deasphalting Plant	3.62	16.40	30.48	1.68	413.6	12.53	2.84	0.6%
4061	F-410 Naphtha Hydrotreater	6.06	19.48	38.10	2.52	524.6	5.46	2.83	0.6%
4191	Cooling Tower SRU	12.94	15.10	16.87	7.32	302.0	1.80	2.39	0.5%
4169	F-731 Isocracker	3.26	15.10	54.86	2.36	632.8	8.52	2.39	0.5%
4042	F-550 5 Rhen Furnace	5.97	19.48	58.22	2.59	505.2	3.58	2.29	0.5%
4168	F-730 Isocracker	3.43	15.10	54.86	2.36	632.8	8.52	2.29	0.5%
—	*All Other Sources*[a]	*6.37*	*17.05*	*25.67*	*4.57*	*382.03*	*2.92*	*88.60*	*18.7%*
	Totals							**472.96**	**100.0%**

[a] In the "*All Other Sources*" row, the $PM_{2.5}$ emissions represent the sum for all sources outside the top 20, and stack parameters represent a weighted average for all sources outside the top 20 (with $PM_{2.5}$ emissions used as the weighting factor).

HRSG, heat recovery steam generator; SRU, sulfur recovery unit.

Figure 2.1.1: Locations of $PM_{2.5}$ sources at Chevron. The 20 largest sources are shown in red, and the FCCU is labeled.

Table 2.1.2: Stack parameters for a FCCU with a WGS installed.

Facility	Stack Diameter (m)	Stack Height (m)	Stack Temperature (°K)	Exit Velocity (m/sec)
Hovensa US Virgin Islands (2011)	3.35	69.34	333.71	20.09
Marathon Refining Garyville, LA (2017–2019)	3.96	68.88	337.76	11.87
Marathon Refining Galveston Bay, TX (2016)	4.21	82.60	350.37	16.29
Valero Benicia, CA (2016–2018)	—	73.00	326.48	—
Average	**3.84**	**73.46**	**337.08**	**16.08**

2.2 Meteorological Modeling

The WRF model (Version 4.1; Skamarock et al., 2019) was used to prepare meteorological inputs to CALPUFF. Four nested domains were used (Figure 2.2.1). The outer domain covered the entire western United States at 36-km horizontal grid resolution to capture synoptic (large-scale) flow features and the impact of these features on local meteorology. The second domain covered California and portions of Nevada at 12-km horizontal resolution to capture mesoscale (subregional) air flow features and their impacts on local meteorology. The third domain covered Central California at 4-km resolution to capture localized air flow features. The 4-km domain included the Bay Area, San Joaquin Valley, and Sacramento Valley, as well as portions of the Pacific Ocean and the Sierra Nevada range. The fourth domain covered the Bay Area and surrounding regions at 1-km resolution. All four domains employed 50 vertical layers, with the layer thickness increasing with height from the surface to the top of the modeling domain (about 18 km).

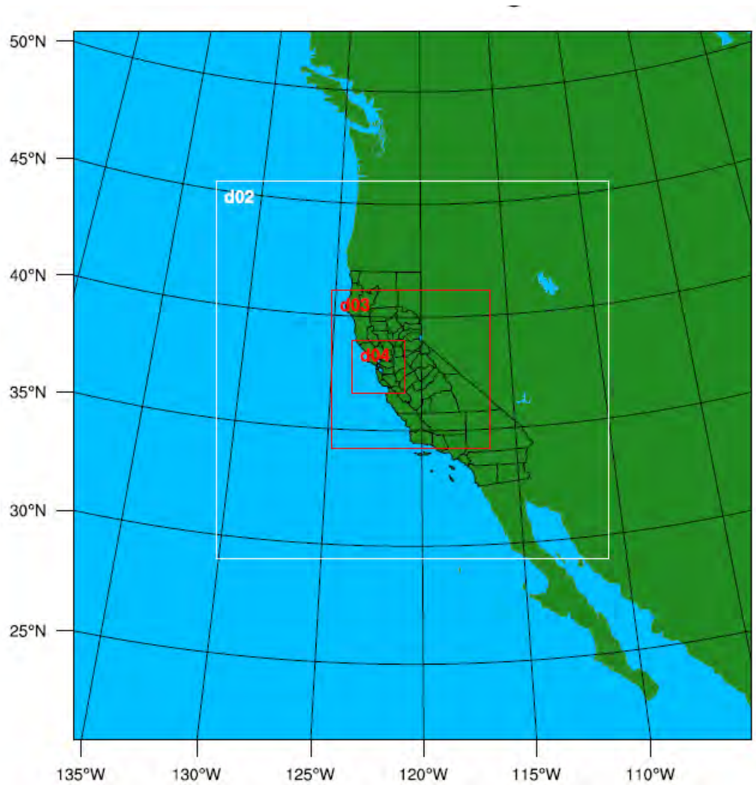

Figure 2.2.1: Nested WRF modeling domains.

The WRF model was tested using available options for physics and dynamics, as well as the datasets used to initialize and drive the model. Options tested included: (1) planetary boundary layer processes, (2) land-surface processes, (3) four-dimensional data assimilation (FDDA) strategies, (4) horizontal and vertical diffusion algorithms, (5) advection schemes, and (6) initial and boundary conditions. Results of each test were evaluated, and the best performing set of options was selected for final modeling.

WRF was applied for 2016, 2017, and 2018. Observed winds and temperatures were ingested into the model as the simulations were performed to increase the representation of local and regional meteorology. Table 2.2.1 provides a summary of annual mean model performance at five observation stations, from Vallejo in the north to San Jose in the south. The performance displayed is typical for the WRF model when it is applied over complex terrain. Variability in station performance is relatively small from year to year and fairly consistent between stations as well.

Example results from the rigorous model evaluation of WRF are provided in Appendix B. The first example shows simulated and observed timeseries plots of winds and temperatures at the Chevron meteorological monitoring station and a comparison between them. The second example shows vertical profiles of simulated and observed temperature and humidity at the Oakland upper air meteorological station for summer and winter days of 2018. A brief discussion on the comparison between simulated and observed fields is also provided.

Table 2.2.1: A summary of the statistical evaluation of WRF for 2016–2018.

2016			**Chevron**	**San Jose**	**Oakland**	**San Pablo**	**Vallejo**
Wind Speed	Bias	(m/s)	−0.69	−1.45	−1.63	−0.44	−0.26
Wind Speed	Gross Error	(m/s)	1.17	1.55	1.80	1.71	0.80
Wind Speed	RMSE	(m/s)	1.41	1.84	2.13	2.02	0.96
Wind Speed	IOA		0.63	0.61	0.59	0.59	0.68
Wind Direction	Bias	(deg)	4.33	16.78	2.37	−2.25	0.50
Wind Direction	Gross Error	(deg)	33.74	41.68	31.99	34.04	33.58
Temperature	Bias	(°K)	0.66	0.77	0.23	0.71	0.84
Temperature	Gross Error	(°K)	1.55	1.35	1.20	1.49	1.42
Temperature	RMSE	(°K)	1.92	1.61	1.46	1.79	1.70
Temperature	IOA		0.84	0.92	0.90	0.84	0.90
2017			**Chevron**	**San Jose**	**Oakland**	**San Pablo**	**Vallejo**
Wind Speed	Bias	(m/s)	−0.70	−1.32	−1.47	−0.71	−0.09
Wind Speed	Gross Error	(m/s)	1.24	1.44	1.68	1.62	0.77
Wind Speed	RMSE	(m/s)	1.50	1.73	2.03	1.97	0.94
Wind Speed	IOA		0.60	0.64	0.60	0.58	0.68
Wind Direction	Bias	(deg)	6.95	20.42	−1.35	−1.41	−0.16
Wind Direction	Gross Error	(deg)	36.94	42.99	33.55	35.95	36.22
Temperature	Bias	(°K)	0.58	0.57	0.47	0.59	0.73
Temperature	Gross Error	(°K)	1.55	1.32	1.40	1.52	1.48
Temperature	RMSE	(°K)	1.91	1.58	1.67	1.81	1.76
Temperature	IOA		0.85	0.92	0.88	0.85	0.90
2018			**Chevron**	**San Jose**	**Oakland**	**San Pablo**	**Vallejo**
Wind Speed	Bias	(m/s)	−0.68	−1.34	−1.50	−0.77	−0.24
Wind Speed	Gross Error	(m/s)	1.22	1.44	1.67	1.56	0.76
Wind Speed	RMSE	(m/s)	1.46	1.72	2.00	1.87	0.93
Wind Speed	IOA		0.58	0.63	0.59	0.58	0.69
Wind Direction	Bias	(deg)	7.45	11.95	0.35	−1.28	−2.80
Wind Direction	Gross Error	(deg)	38.57	39.04	33.34	36.22	34.03
Temperature	Bias	(°K)	0.81	0.60	1.09	0.72	0.70
Temperature	Gross Error	(°K)	1.58	1.29	1.45	1.64	1.47
Temperature	RMSE	(°K)	1.97	1.56	1.78	1.96	1.78
Temperature	IOA		0.85	0.93	0.88	0.84	0.91

2.3 Application of CALPUFF

Meteorological inputs to CALPUFF were prepared using outputs from the WRF model. The Mesoscale Model Interface (MMIF) computer program (Version 3.4.1; Brashers and Emery, 2019) was used for this purpose. This program extracts parameters from WRF outputs that are needed as CALPUFF inputs, such as wind speed, temperature, mixing height, surface roughness length, land use category, terrain elevation, and leaf area index.

MMIF provides two options for diagnosing the gridded Pasquill–Gifford (PG) stability classes required by CALPUFF. The first option is called the Solar Radiation/Delta-T (SRDT) method, which derives the PG stability class based on wind speed, solar radiation, and temperature (EPA, 1993). The second option derives the stability class from the parameterization of relationships between Monin–Obukhov lengths and surface roughness (Golder, 1972). The second option was selected for this project, and this choice is consistent with recent BAAQMD AERMOD applications in West Oakland.

CALPUFF uses far fewer vertical layers than WRF. MMIF performs a down-scaling of high resolution WRF layers to CALPUFF layers. CALPUFF layers used in this study were based on recommendations developed by modelers from the EPA and the Federal Land Manager (FLM) community (EPA, 2009). The layer definition is shown in Table 2.3.1.

Table 2.3.1: CALPUFF layers above ground level.

Layer	Layer Top Height (m)
1	20
2	40
3	80
4	160
5	320
6	640
7	1,200
8	2,000
9	3,000
10	4,000

CALPUFF provides many options for selecting model processes, such as wet scavenging, dry deposition, stack tip downwash, and building downwash. These options can be selected and assigned a value; if not selected, no value is assigned. The available options were carefully reviewed and selected for handling complex terrain with diverse meteorological conditions. The selected options and their values are shown in Appendix C.

CALPUFF simulations were performed for three years (2016–2018) and for two receptor grid configurations. The first simulation used 1-km computational and receptor domains over the entire Bay Area and included emissions from all point sources at the Chevron facility. Annual average $PM_{2.5}$ concentrations were estimated for each year. The purpose of this simulation was to identify the areal extent of annual average concentrations exceeding 0.1 $\mu g/m^3$.

The second simulation used 1-km computational and 100-m receptor domains over the area for which annual average concentrations exceeded 0.1 $\mu g/m^3$ from the first simulation. A 5-km buffer zone was established between areas with concentrations exceeding 0.1 $\mu g/m^3$ and boundaries of 100-m receptor domain to minimize boundary impacts on estimated concentrations. The second simulation also included emissions from all point sources at this facility. The purpose of the second simulation was to increase the density of receptors at locations where $PM_{2.5}$ concentrations were highest.

An additional simulation was conducted that used the same computational and receptor domains as the second simulation, but only included $PM_{2.5}$ emissions from the FCCU (with and without a WGS installed) at Chevron.

Figure 2.3.1 shows the 1-km (gray box) and 100-m (red box) receptor domains used for all simulations. This figure also shows three-year (2016–2018) average $PM_{2.5}$ concentrations at 1-km receptor resolution that included emissions from all point sources at the Chevron facility.

For all simulations, background (regional) concentrations and incoming pollutants through boundaries of the modeling domain were set to zero. In other words, estimated concentrations are entirely from facility emissions.

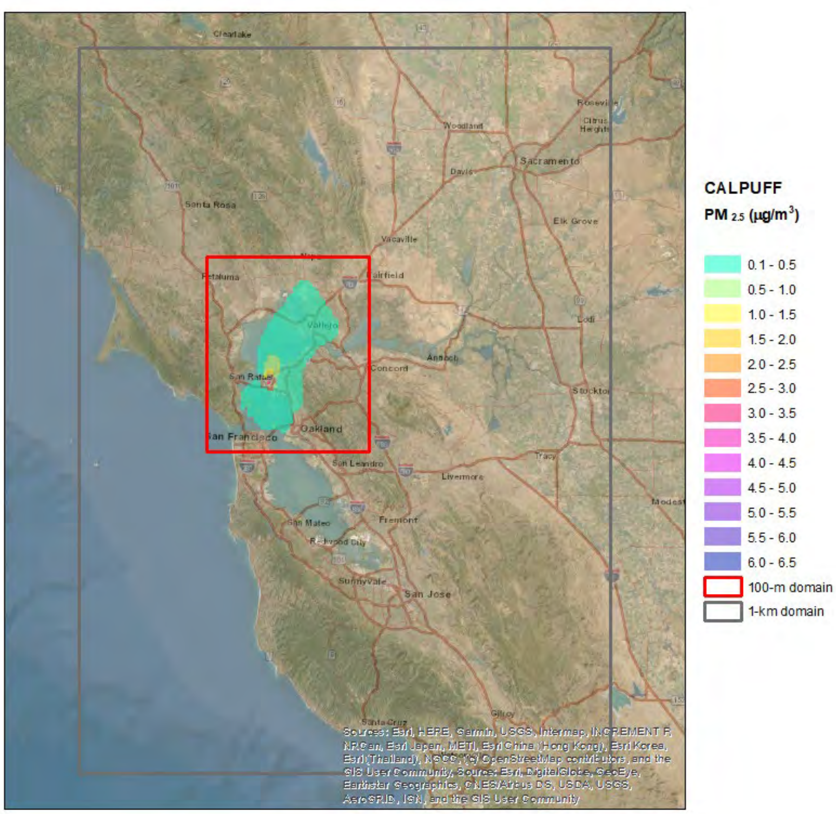

Figure 2.3.1: The gray and red boxes show the 1-km and 100-m receptor domains, respectively. CALPUFF-simulated three-year average $PM_{2.5}$ concentrations are also shown.

Results

3.1 Simulations with Emissions from All Sources

Figure 3.1.1 shows the three-year (2016–2018) average CALPUFF-simulated $PM_{2.5}$ concentrations for the 100-m receptor domain. Estimated concentrations within the Chevron facility fence line are not shown. Estimated concentrations below 0.1 µg/m^3 are also excluded.

CALPUFF estimates concentrations at receptor points located at the center of each 100 x 100 m grid cell. For mapping purposes, each grid cell is color coded based on the concentration value at its center. An interval of 0.5 µg/m^3 was selected for color coding, except for concentrations between 0.1 µg/m^3 and 0.5 µg/m^3.

As can be seen in Figure 3.1.1a, the lowest concentration bin (0.1 µg/m^3 to 0.5 µg/m^3) extends from near Treasure Island in the south to American Canyon in the north and from Tiburon in the west to Vallejo in the east. The emissions plume has an elongated shape in the southwesterly and northeasterly directions from Richmond, consistent with the predominant winter and summer wind patterns there, respectively.

The area with concentrations above 0.5 µg/m^3 is much smaller than the area covered by the lowest concentration bin, as described above. These higher concentrations are mostly confined to the area around the Chevron facility and extend toward the northeast of the facility.

To better visualize the high-concentration areas, a zoomed-in map of the 100-m receptor domain was created (see Figure 3.1.1b). As shown in this figure, an area with concentrations between 0.5 µg/m^3 and 1.0 µg/m^3 extends from downtown Richmond in the south to a location over the bay in the north and from Point Molate in the west to near downtown Pinole in the east. Concentrations below 1.0 µg/m^3 extend to residential areas on the east, south, and west sides of the Chevron facility.

Concentrations above 1.0 µg/m^3 primarily lie on the north side of the facility over the bay; however, this area extends to the shoreline toward the northeast of the facility. In addition, a sharp concentration gradient is apparent near the facility fence line. The maximum concentration (5.9 µg/m^3) is located just outside the facility fence line.

Additional analyses on the modeling results are presented in Appendix D.

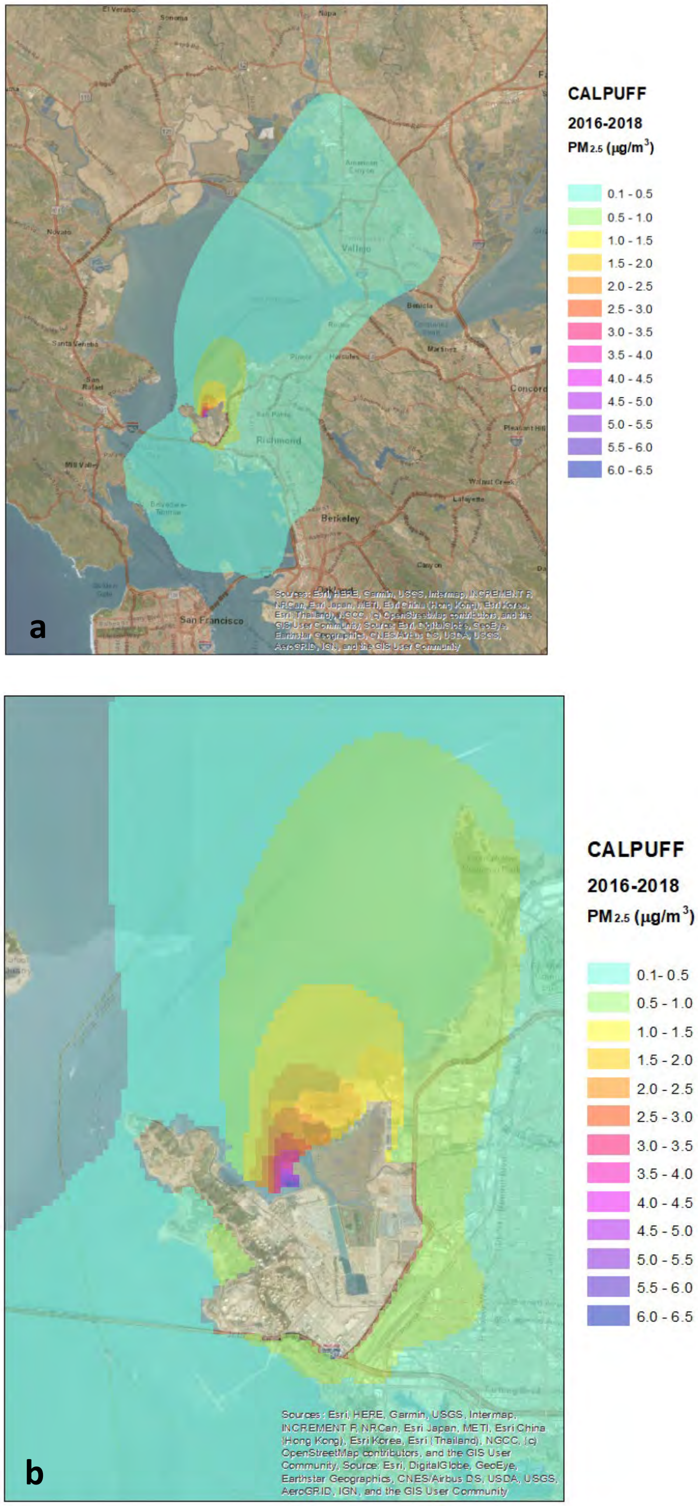

Figure 3.1.1: Three-year (2016–2018) average CALPUFF-simulated $PM_{2.5}$ concentrations for (a) the 100-m receptor domain and (b) a zoomed-in area of highest concentrations. Emissions from all (119) point sources are included in these simulations. Concentrations inside the Chevron fence line and that are below 0.1 µg/m^3 are not shown.

3.2 Simulations with FCCU Emissions

CALPUFF was also run with emissions from the FCCU only, and the resulting three-year average $PM_{2.5}$ concentrations are shown in Figure 3.2.1 (FCCU without a WGS) and Figure 3.2.2 (FCCU with a WGS installed). Again, concentrations within the facility fence line and below 0.1 μg/m^3 are not shown. An interval of 0.1 μg/m^3 was selected for color coding concentration values at grid cells.

Emissions from this source are mainly transported to the northeast of the facility, consistent with the predominant summer wind pattern. An area with concentrations between 0.1 μg/m^3 and 0.2 μg/m^3 passes Pinole Point but does not reach Vallejo. This area also extends towards the City of Richmond. The number of receptors with three-year average concentrations above 0.1 μg/m^3 was reduced from 66,659 (all-source simulation) to 8,499 (FCCU-only simulation), i.e., a 87% reduction. The maximum three-year average concentration from this source is 0.97 μg/m^3, or about 16% of the maximum concentration from the all-source simulation. Emissions from the FCCU, however, account for about 48% of total $PM_{2.5}$ emissions from the facility. This discrepancy is likely due to release characteristics for this source, which has a 46-m tall stack and a gas exit temperature of 505°K. These stack parameters indicate that under most atmospheric conditions, emissions from this source may remain in aloft layers for some distance downwind compared with emissions from other sources.

Installation of a WGS further reduces the number of receptors with three-year average concentrations above 0.1 μg/m^3 to 1,250 (an 85% reduction from the baseline FCCU emission scenario) and reduces the maximum three-year average concentration to 0.50 μg/m^3 (52% of the maximum concentration from the baseline FCCU emission scenario). This reduction in the maximum concentration is somewhat smaller than the emission reduction by a WGS (65%).

Table 3.2.1 shows the key findings of simulations with three sets of emissions.

Table 3.2.1: Key findings of simulations with emissions from all point sources, FCCU only, and FCCU with assumed WGS.

	Annual $PM_{2.5}$ emissions (tons/year)	**Maximum simulated concentrations (μg/m^3)**	**Number of sampling receptors with concentrations above 0.1 μg/m^3**
All point sources	472.96	5.9	66,659
FCCU only	228.61	0.97	8,499
FCCU with assumed WGS	80.01	0.50	1,250

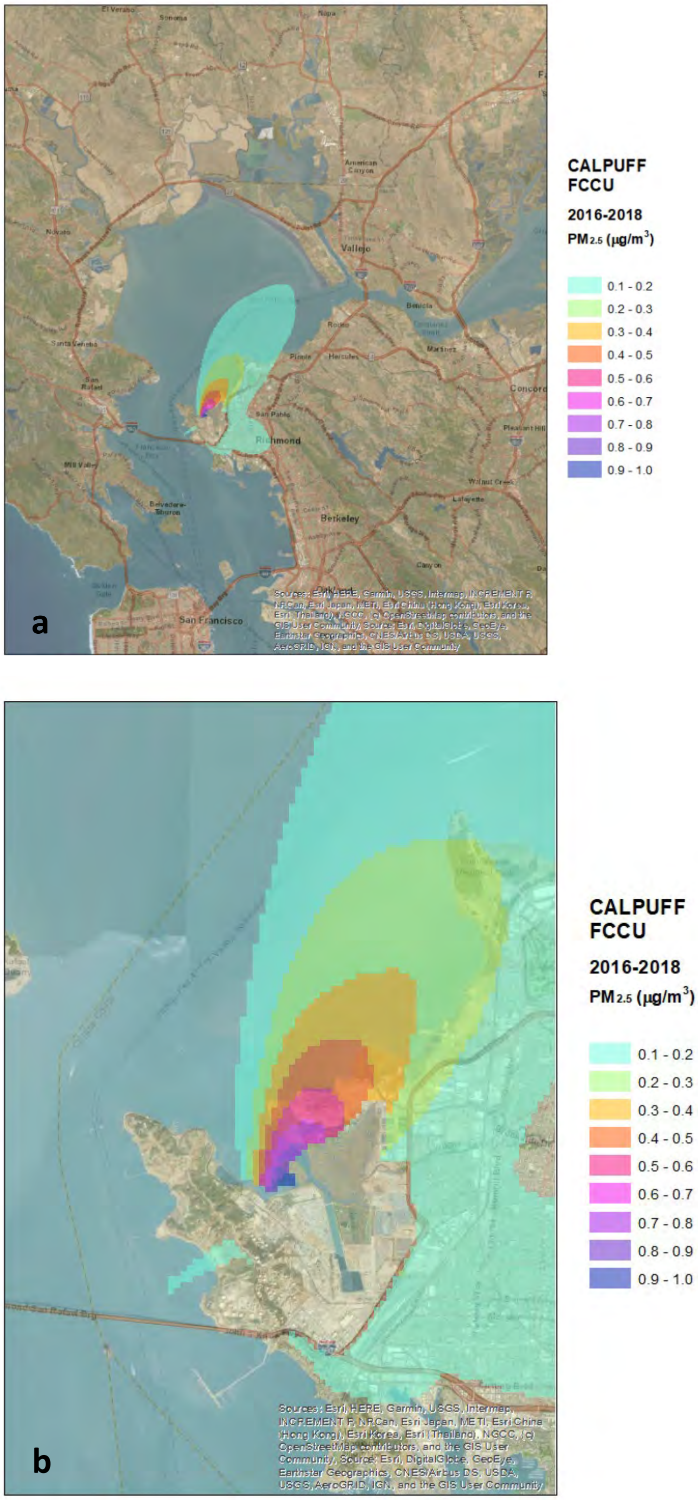

Figure 3.2.1: Three-year (2016–2018) average CALPUFF-simulated $PM_{2.5}$ concentrations for: (a) the 100-m receptor domain, and (b) a zoomed-in area of high concentrations. Emissions from the FCCU only (without a WGS) are included in these simulations. Concentrations inside the Chevron fence line and that are below 0.1 μg/m^3 are not shown.

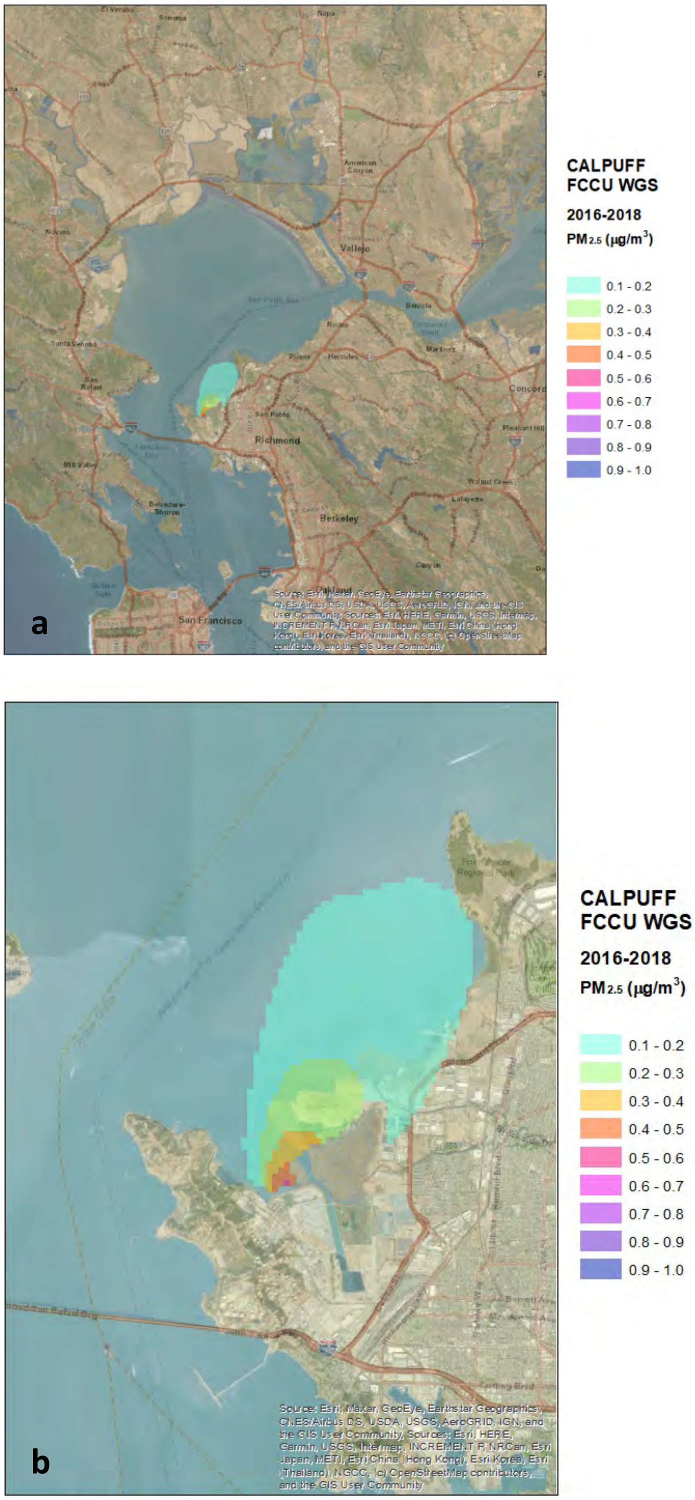

Figure 3.2.2: Three-year (2016–2018) average CALPUFF-simulated $PM_{2.5}$ concentrations for: (a) the 100-m receptor domain, and (b) a zoomed-in area of high concentrations. Emissions from the FCCU only (with an assumed WGS) are included in these simulations. Concentrations inside the Chevron fence line and that are below 0.1 μg/m^3 are not shown.

Summary

The purpose of this project is to estimate contributions of directly emitted fine particulate matter from major industrial facilities in the Bay Area to ambient $PM_{2.5}$ concentrations. Project findings are expected to support the District's AB 617 program, providing technical information to decision makers, planners, the AB 617 technical assessment team, and rule developers.

For this initial phase of the project, we estimated contributions of emissions from the Chevron refinery to ambient $PM_{2.5}$ levels for 2016–2018. Modeling analyses of the impacts of emissions from other Bay Area refineries and the Lehigh Cement factory on ambient $PM_{2.5}$ levels are under way using an approach similar to the one used for the Chevron refinery.

The technical approach developed for this project was carefully evaluated. Options were weighed and discussed among the modeling team, and the strategy that was anticipated to provide the best modeling results was adopted. In addition, consideration was given to providing results that would support the needs of anticipated end users.

The opening sections of this document provide detailed information on the purpose of the project, model selection, and types of analyses conducted. This document also provides a summary of emissions and meteorological input preparation, model execution, analysis and interpretation of model outputs, and QA/QC performed.

Key findings of the project include:

- Simulating three years provides better representation of average concentrations.
- CALPUFF results show some differences among the years simulated, but overall characteristics of the simulated $PM_{2.5}$ concentrations are consistent among the years.
- The single FCCU that accounts for about 48% of total $PM_{2.5}$ emissions from Chevron contributes about 16% of the peak three-year average contributions from all Chevron sources.
- Installation of a WGS, which reduces the FCCU emissions by 65%, reduces the peak three-year average contribution from the FCCU by 48%.
- The peak annual average $PM_{2.5}$ concentration is just outside the facility's northern fence line, but concentrations quickly diminish a short distance away from the facility.
- Peak monthly average $PM_{2.5}$ concentrations are higher in summer than in winter due to stronger vertical mixing during the summer months.

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Appendix A – Emissions Inventory Preparation

As described in the body of this report, QC checks were performed on stack parameters for Chevron $PM_{2.5}$ sources prior to modeling. Table A.1 shows the results of range checks for each stack parameter, a step that was taken to ensure that all values fall within reasonable bounds.

In addition, the base elevation and stack height for each modeled source were added to calculate an effective stack height. These values were then compared with the vertical layer structure of the CALPUFF model to determine how emissions would be apportioned vertically. This comparison does not include plume rise.

About 388 tons of $PM_{2.5}$ (82% of the total) were being injected into CALPUFF layer 3, which begins at a height of 60 m and is 40 m thick, as shown in Table A.2.

Table A.1: Results of range check for stack parameters assigned to Chevron sources.

Parameter	Base Elevation (m)	Stack Height (m)	Stack Diameter (m)	Exit Temperature (°K)	Exit Velocity (m/s)	$PM_{2.5}$ Emissions (tons/year)
Minimum	0	1.83	0.09	293.15	1.60	0.0001
Maximum	25.71	75.76	8.53	1273.15	53.35	228.6

Table A.2: Results of mapping sources and emissions to CALPUFF layers.

CALPUFF Layer	Layer Top Height (m)	Layer Thickness (m)	Number of Sources	$PM_{2.5}$ Emissions (tons/year)
1	20	20	26	3.44
2	40	20	55	81.21
3	80	40	37	387.78
4	160	80	1	0.53
5	320	160		
6	640	320		
7	1,200	560		
8	2,000	800		
9	3,000	1,000		
10	4,000	1,000		

Appendix B – Meteorological Model Evaluation

The WRF model was applied for three years (2016–2018) and evaluated against available surface and upper air observations, especially for its 1-km modeling domain. Ramboll's METSTAT program[2] was used for evaluating the model against surface observations. This program compares hourly average WRF-simulated meteorological fields against observations, calculates statistical measures such as mean observation, mean simulation, bias, error, gross error and index of agreement, and tabulates and graphically displays findings.

For evaluating the model against upper air measurements, a skew-T plot program was used. This program plots simulated and observed temperatures and humidity in the vertical direction.

A summary table of estimated statistical measures is provided in the main body of this document. Time series comparisons between simulated and observed wind speed, wind direction, and temperatures are presented in Section B.1. Sample skew-T plots are presented in section B.2.

B.1 Time Series Comparisons

We compared simulated winds and temperatures against observations to evaluate the model. Even though the model was evaluated against available observations archived at the National Center for Atmospheric Research and in the District's Data Management System, in this Appendix, we show time series plots only at the Chevron facility. To better show comparison details, time series plots are displayed for discrete calendar quarters.

Figures B.1 through B.9 show time series plots of daily average observed and WRF-simulated wind speed, wind direction, and temperature for 2016, 2017, and 2018, respectively. As these figures show, the WRF-simulated winds and temperatures match the observed trends exceptionally well for the whole simulation period. This model performance is due to the Modeling and Analysis Section's continuous evaluation of WRF and efforts to improve model performance where possible. Ingesting data from the relatively dense Bay Area observation network into WRF also helps improve its performance.

Note that the y-axis showing wind direction spans from 0 to 360 degrees in Figures B.2, B.5, and B.7. Comparing wind directions slightly above 0 degrees and below 360 degrees can be falsely interpreted as significant mismatches between observations and simulations. In fact, 0 and 360 degrees overlap and directions slightly above 0 degrees and below 360 degrees should be interpreted as being in reasonably good agreement.

Despite overall good performance, the WRF model systemically underestimates wind speed and overestimates temperatures during summer months. This behavior of WRF may be caused by

[2] http://www.camx.com/download/support-software.aspx

several factors and is more pronounced at the Chevron meteorological site compared with other sites in the region (data not shown). Influencing factors likely include a sharp temperature gradient between the Pacific Ocean and inland that promotes the development of a strong sea breeze in the afternoons of most summer days, a sharp water–land contrast, and strong terrain influence on air flow. It is unlikely the model will be able to resolve these physical features at 1-km resolution.

The overestimation of temperature is thought to be due to an underestimation of wind speeds, which can result in a lack of inland penetration of the cold marine layer.

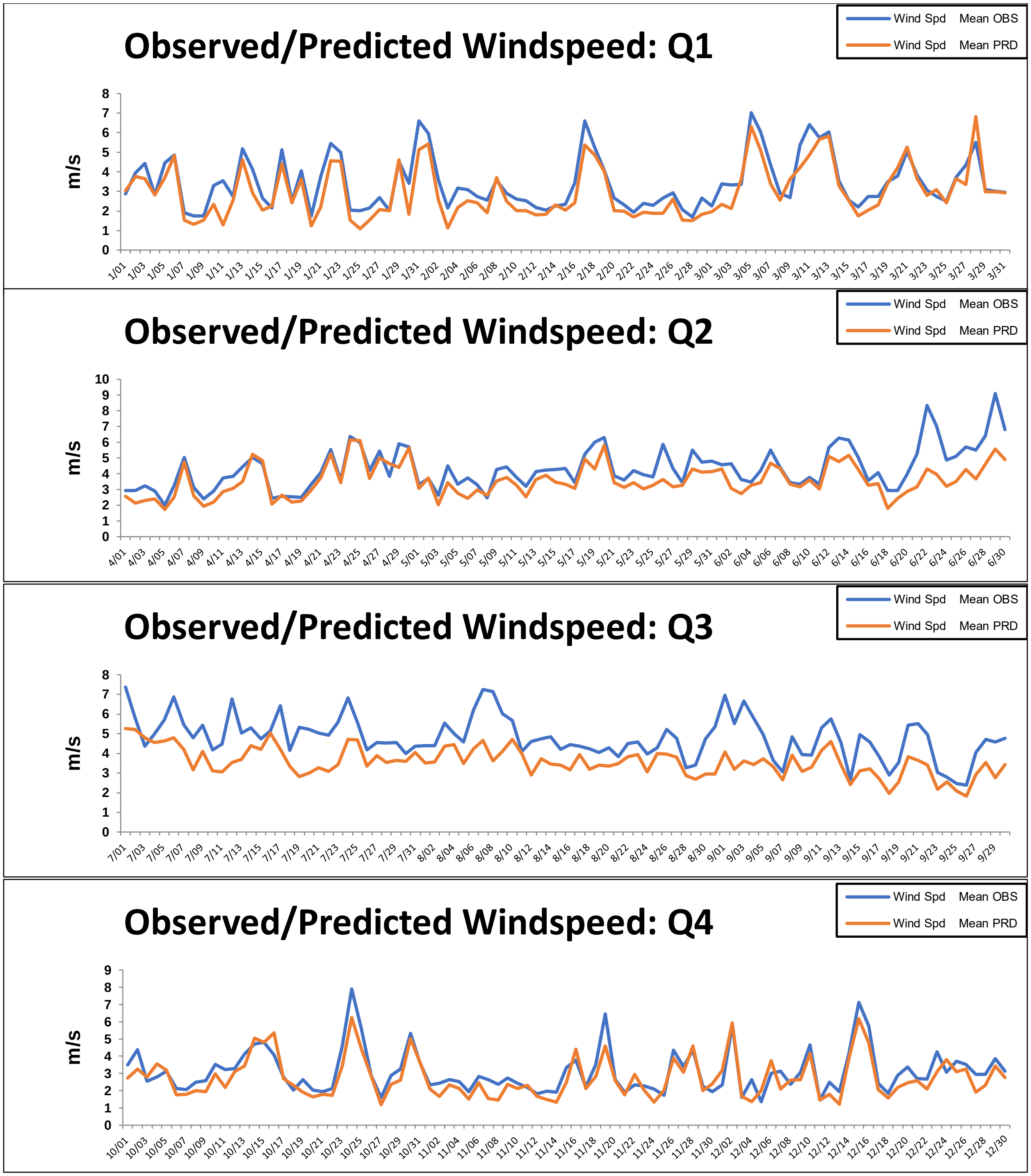


Figure B.1: Daily time series of observed and simulated wind speed at the Chevron meteorological tower in Richmond for each quarter of 2016. “Mean OBS” is for all observations averaged over the 1-km domain. “Mean PRD” is for all prediction fields at the observation sites averaged over the 1-km domain.

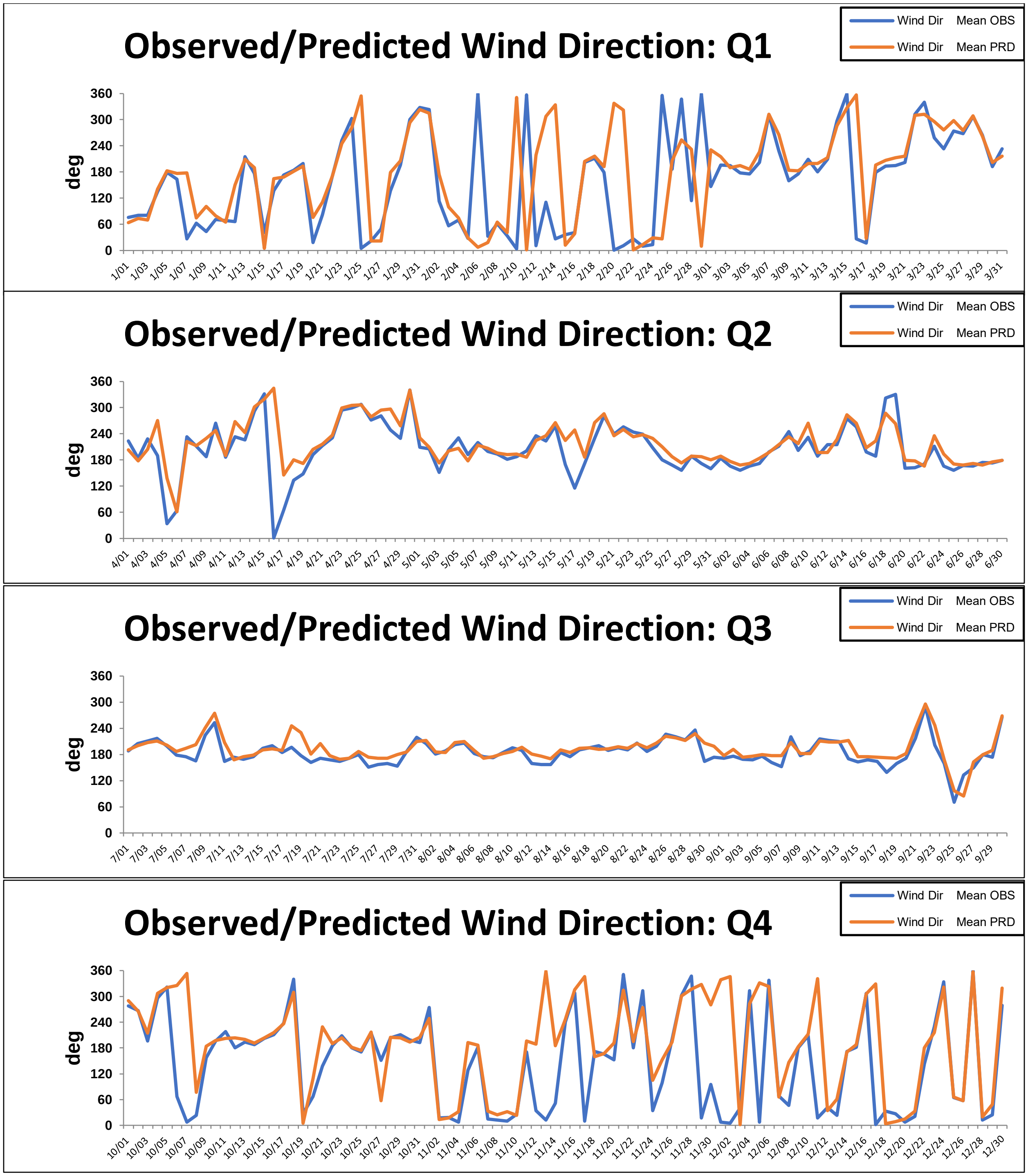


Figure B.2: Daily time series of observed and simulated wind direction at the Chevron meteorological tower in Richmond for each quarter of 2016. Note that 0 and 360 degrees overlap.

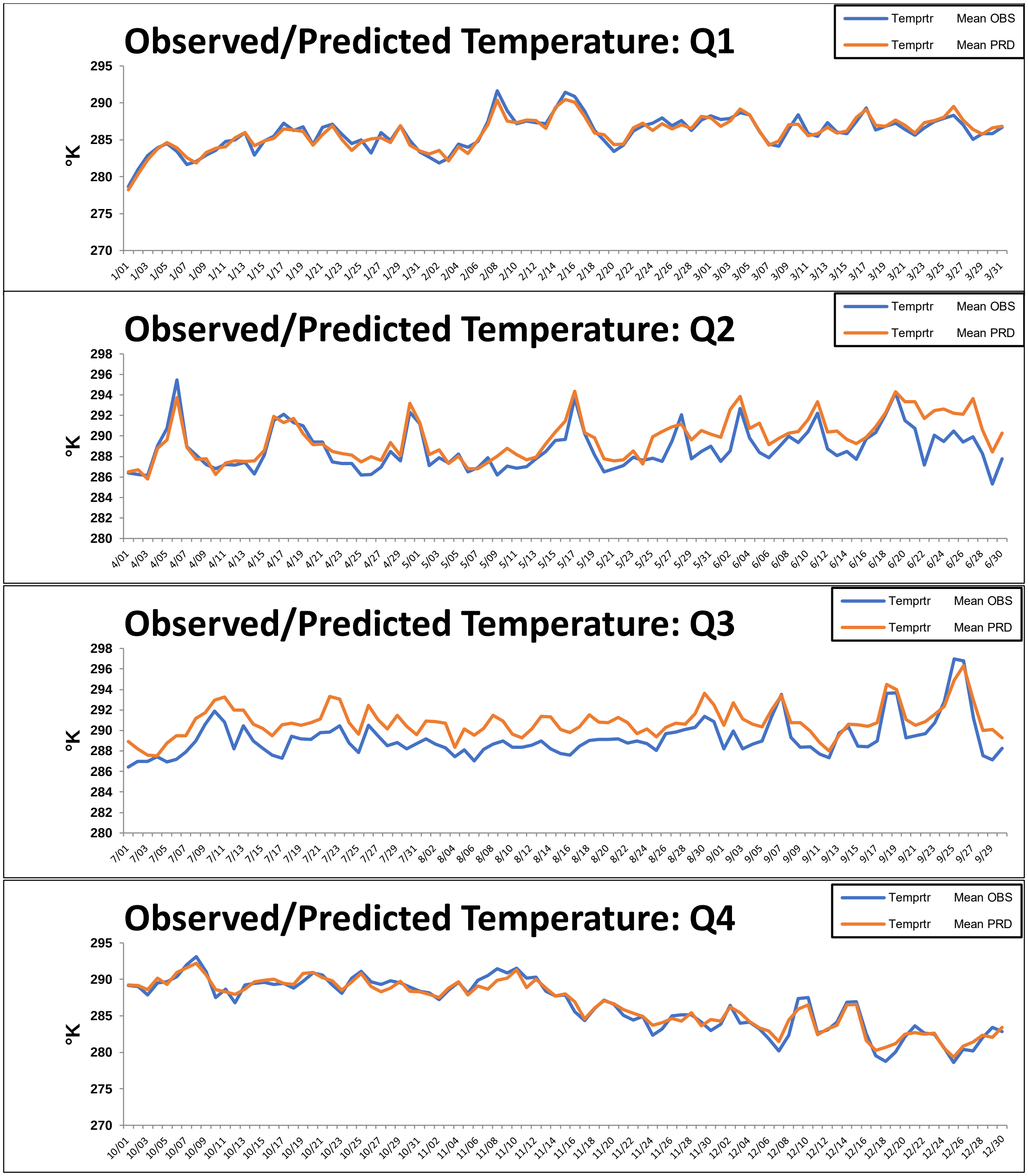


Figure B.3: Daily time series of observed and simulated temperature at the Chevron meteorological tower in Richmond for each quarter of 2016.

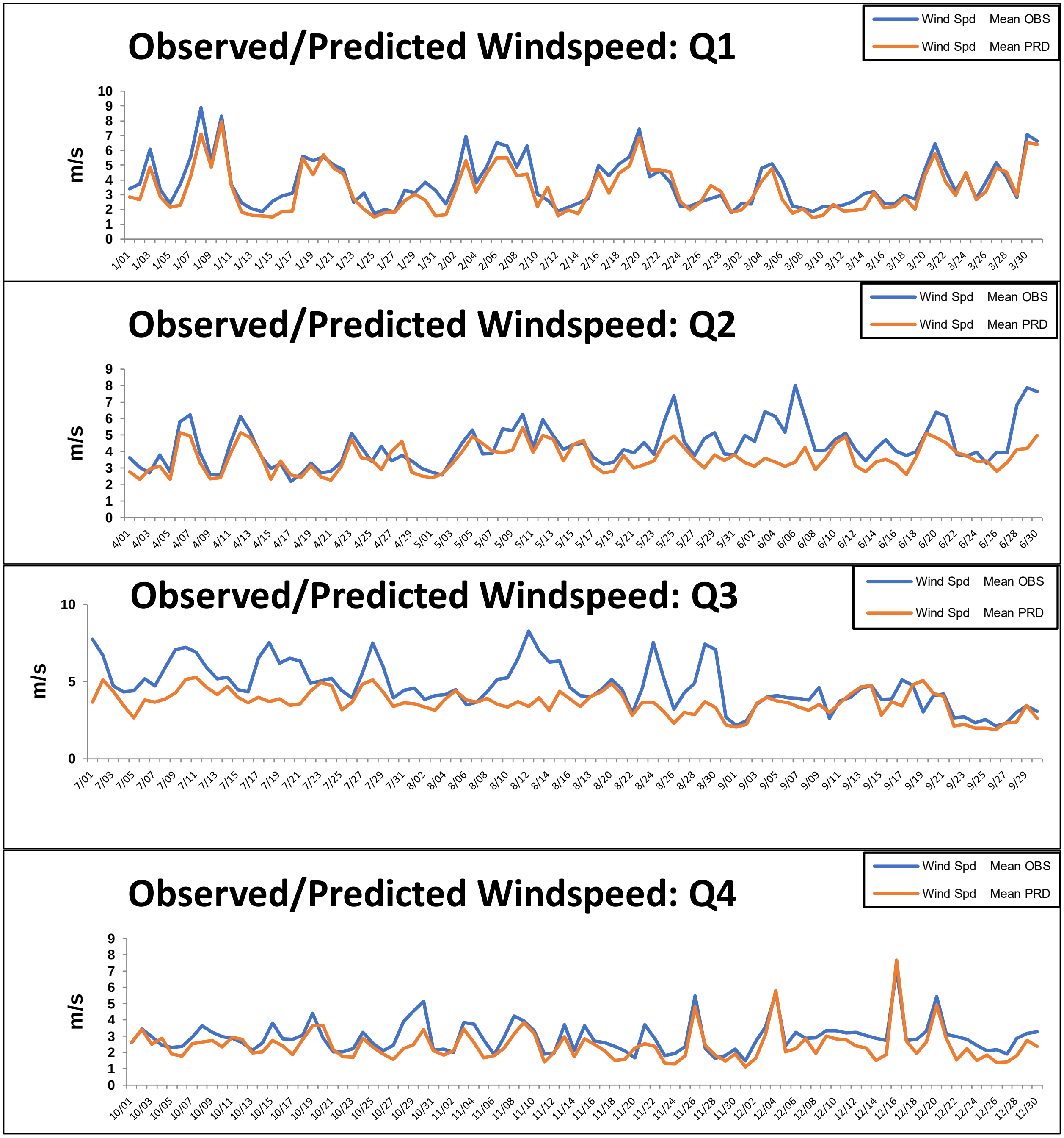


Figure B.4: Daily time series of observed and simulated wind speed at the Chevron meteorological tower in Richmond for each quarter of 2017. “Mean OBS” is for all observations averaged over the 1-km domain. “Mean PRD” is for all prediction fields at the observation sites averaged over the 1-km domain.

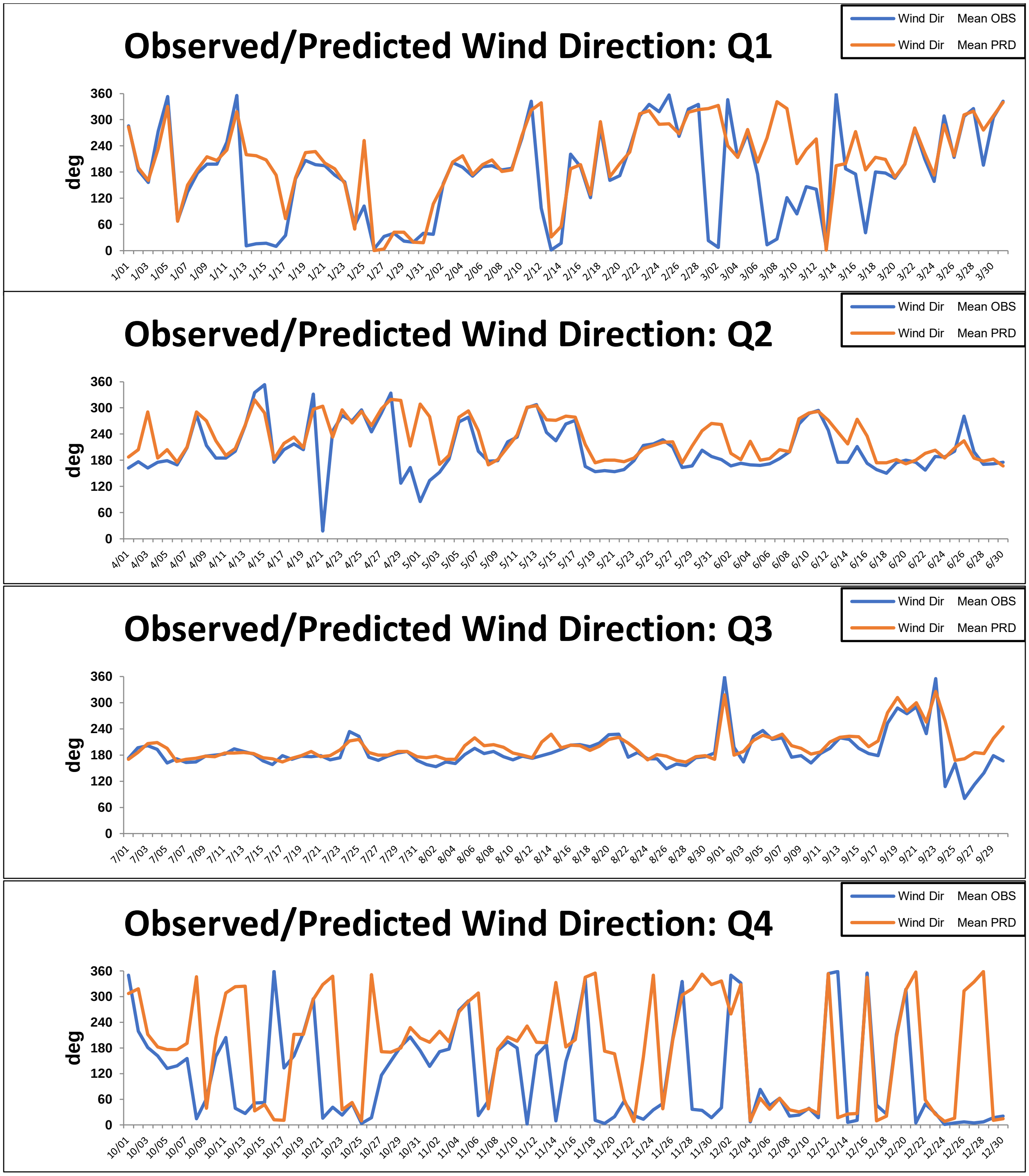


Figure B.5: Daily time series of observed and simulated wind direction at the Chevron meteorological tower in Richmond for each quarter of 2017. Note that 0 and 360 degrees overlap.

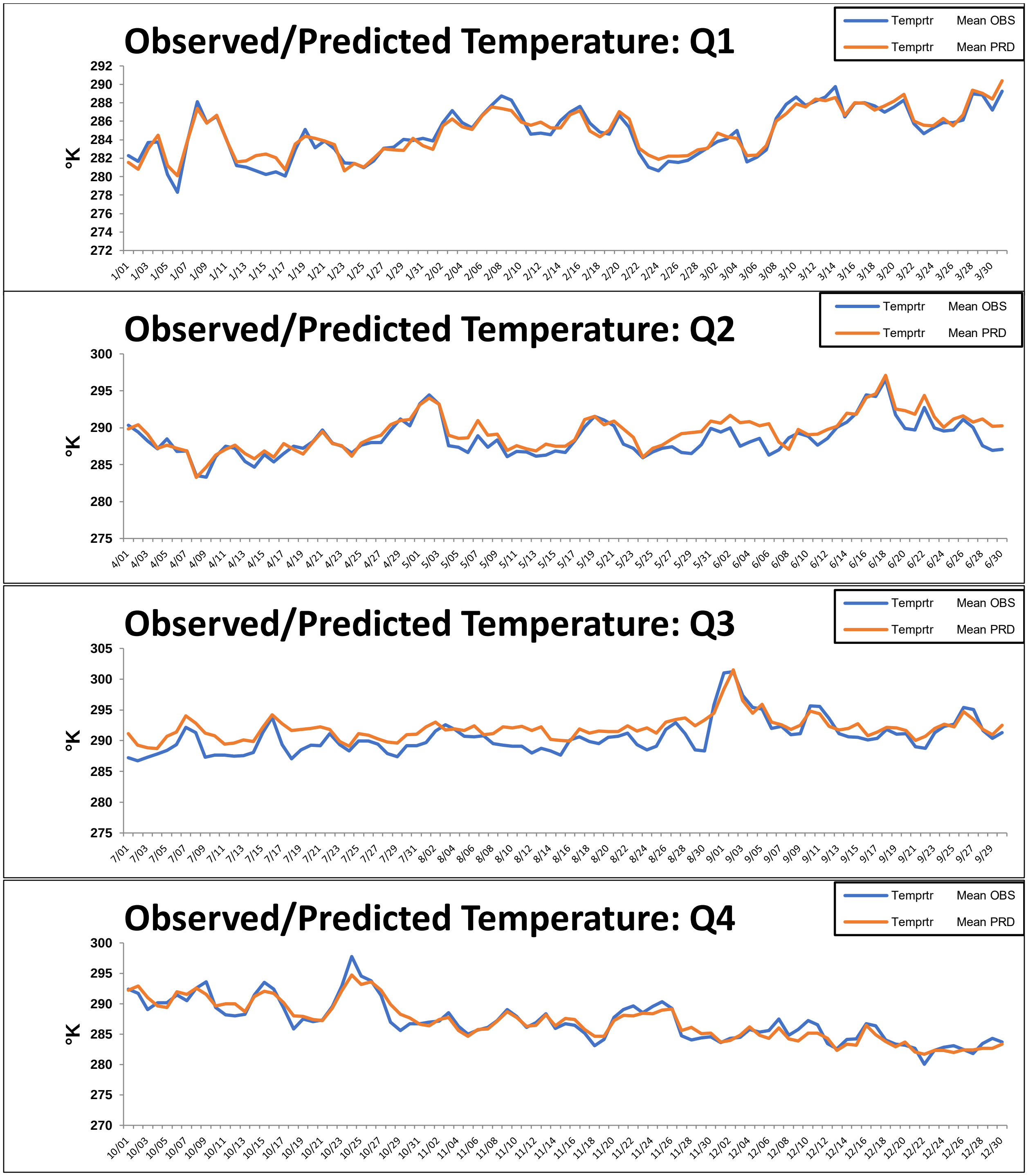


Figure B.6: Daily time series of observed and simulated temperature at the Chevron meteorological tower in Richmond for each quarter of 2017.

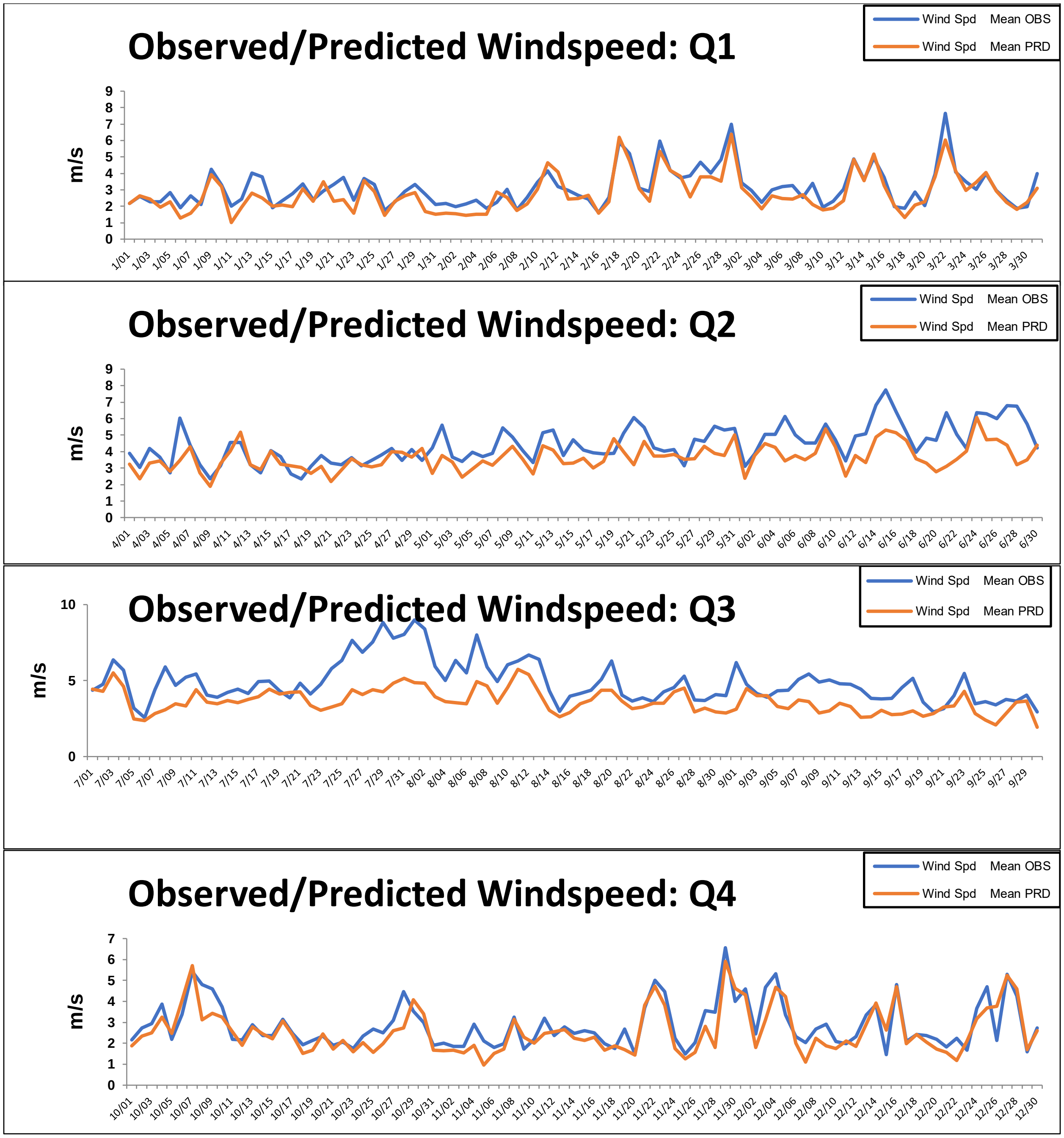


Figure B.7: Daily time series of observed and simulated wind speed at the Chevron meteorological tower in Richmond for each quarter of 2018. “Mean OBS” is for all observations averaged over the 1-km domain. “Mean PRD” is for all prediction fields at the observation sites averaged over the 1-km domain.

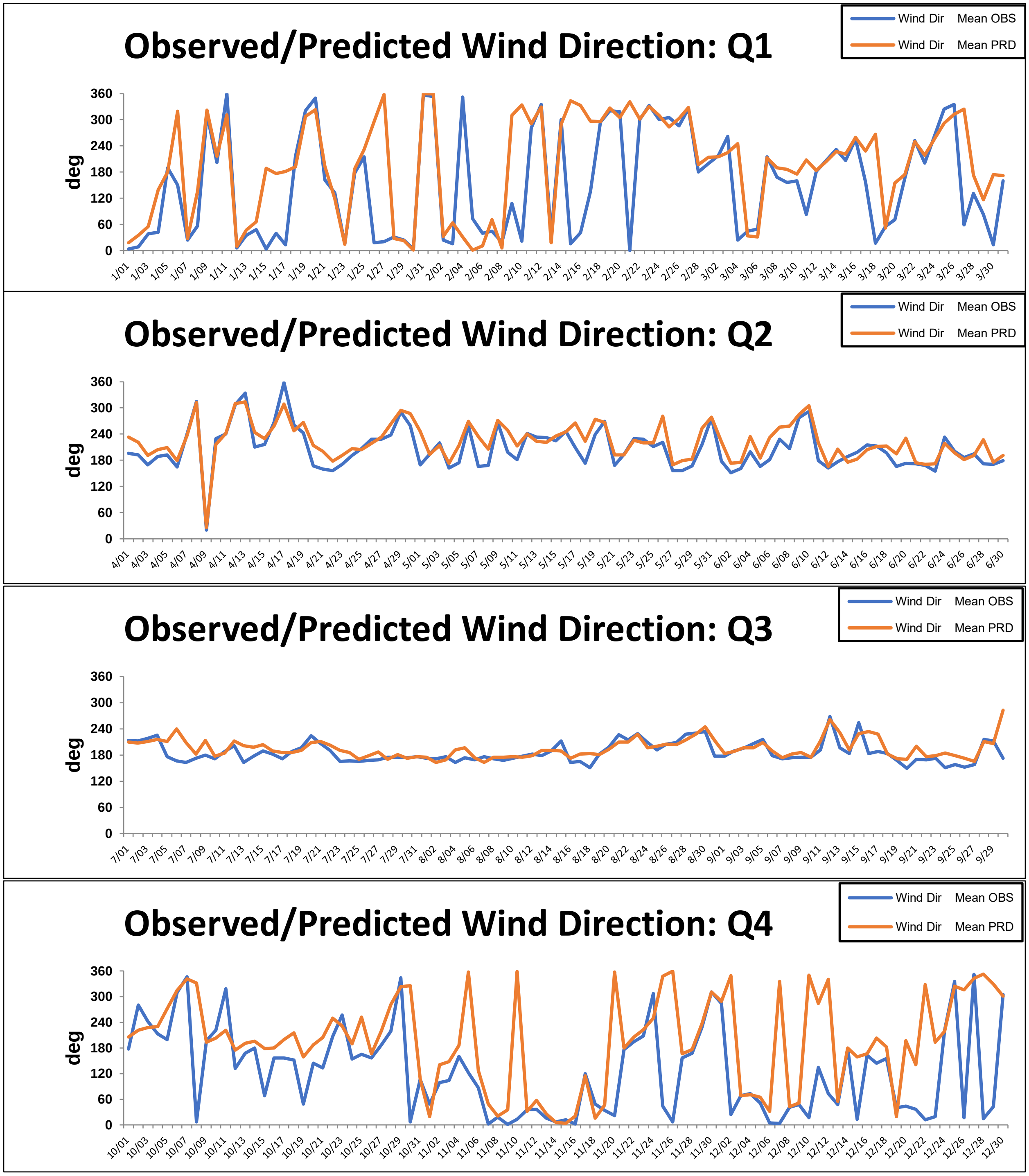


Figure B.8: Daily time series of observed and simulated wind direction at the Chevron meteorological tower in Richmond for each quarter of 2018. Note that 0 and 360 degrees overlap.

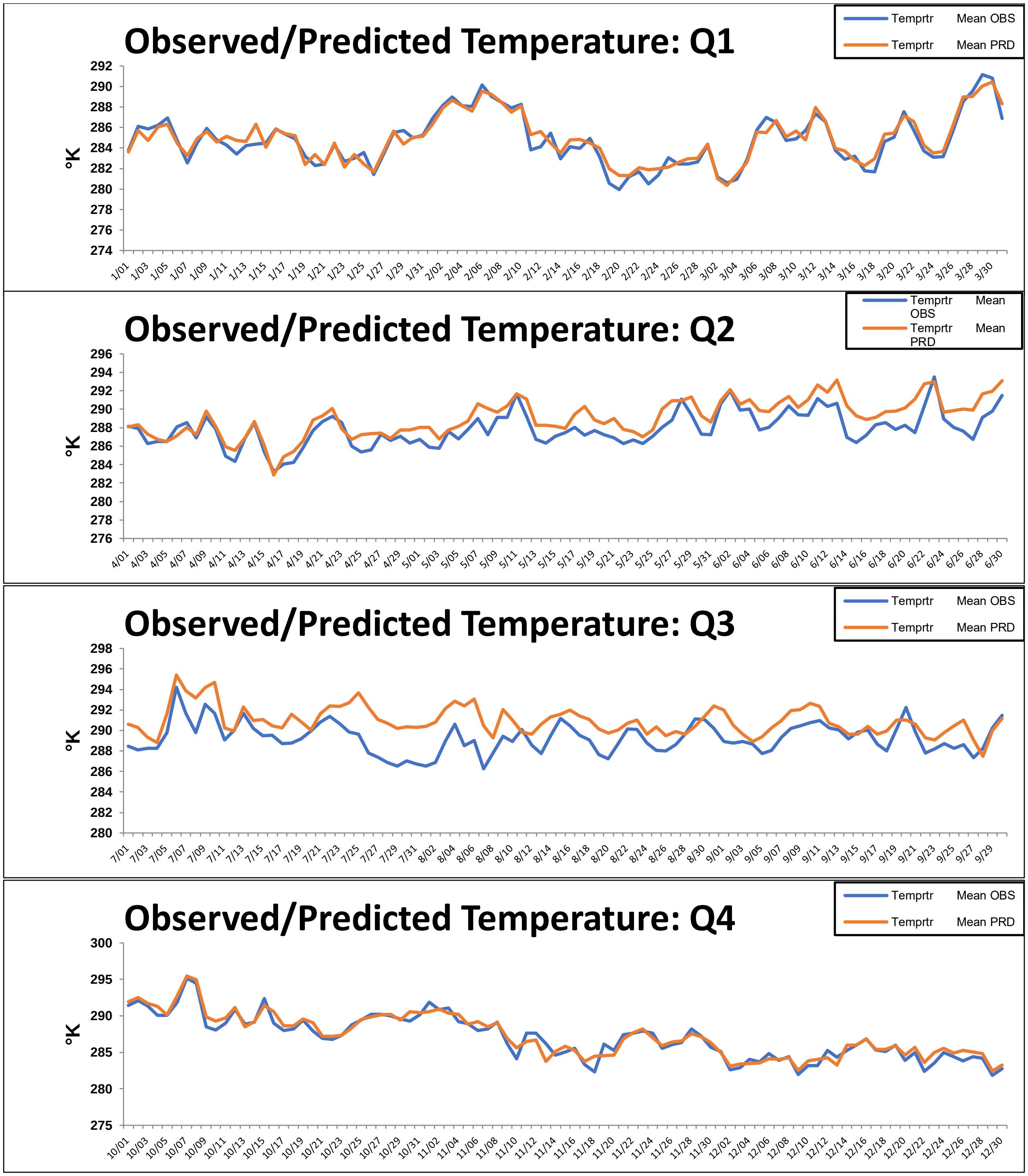


Figure B.9: Daily time series of observed and simulated temperature at the Chevron meteorological tower in Richmond for each quarter of 2018.

B.2 Evaluating the WRF Model Against Upper Air Measurements

One upper air meteorological measurement station, located at the Oakland International Airport and operated by the National Weather Service, is within the 1-km WRF modeling domain. Two daily measurements are conducted at 00 GMT and 12 GMT (4:00 pm and 4:00 am PST, respectively).

Outputs for the 1-km WRF model domain were compared with measurements at this site. Day by day, simulations matched observations exceptionally well. Figures B.10 and B.11 show comparisons between simulations and observations for a winter and summer day for 2018. These days are randomly selected for the purpose of demonstration. They do not necessarily show the best or worst match between the simulations and observations.

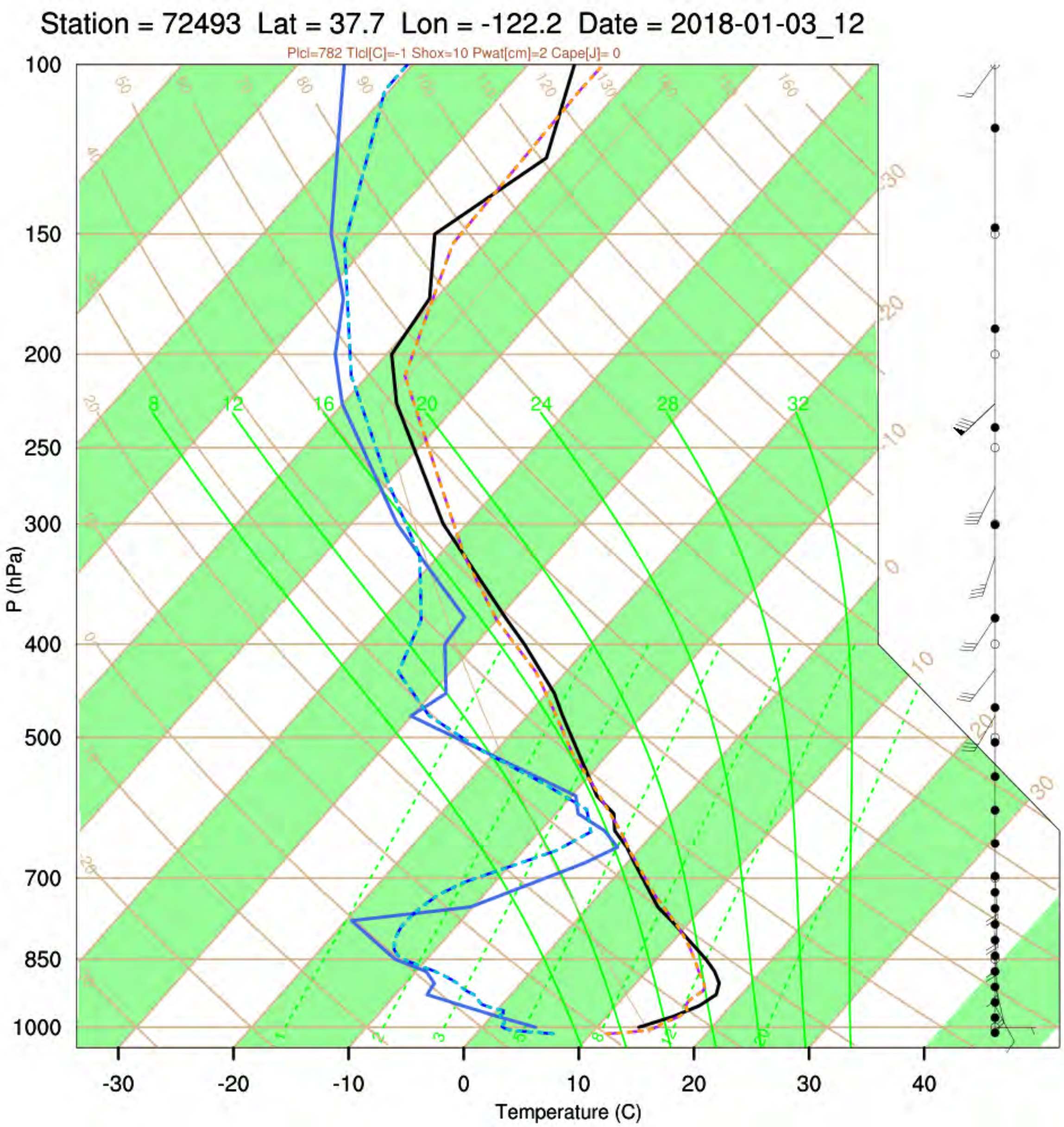


Figure B.10: A skew-T plot showing simulated (dashed lines) and observed (solid lines) temperatures (orange and black) and humidity (blue) at Oakland on January 3, 2018, at 12 GMT. Observed wind barbs at pressure levels are shown on the right y-axis.

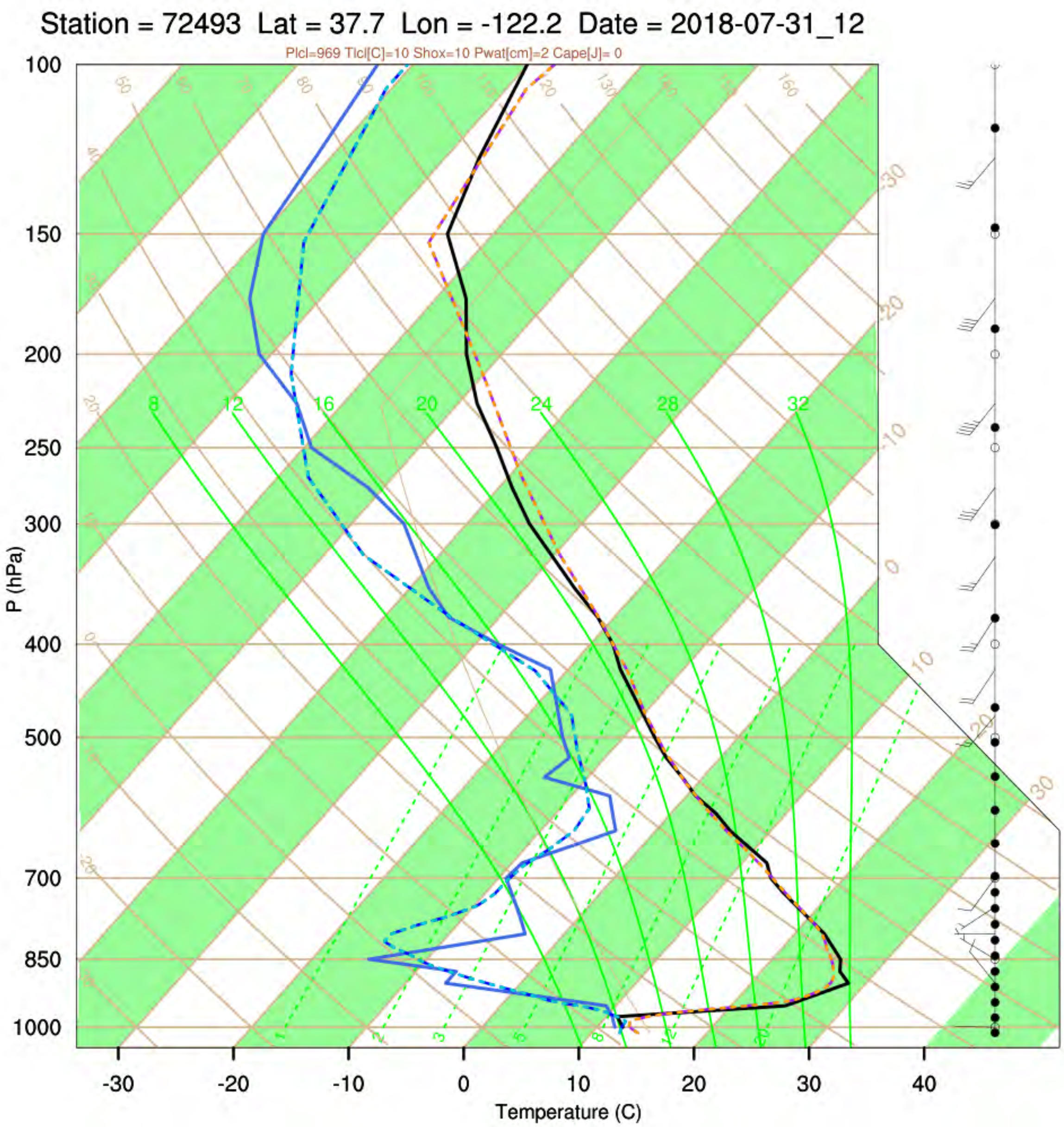


Figure B.11: A skew-T plot showing simulated (dashed lines) and observed (solid lines) temperatures (orange and black) and humidity (blue) at Oakland on July 31, 2018, at 12 GMT. Observed wind barbs at pressure levels are shown on the right y-axis.

Appendix C – CALPUFF Modeling Options

Primary $PM_{2.5}$ emitted from the Chevron facility was modeled as an inert $PM_{2.5}$ species, i.e., secondary $PM_{2.5}$ formation in the atmosphere was not considered for this project. Pollutant removal processes due to wet scavenging and dry deposition were included. Parameters for wet scavenging and dry deposition are shown in Table C.1. Other CALPUFF modeling options used in this study are listed in Table C.2.

Table C.1: Parameters for wet scavenging and dry deposition.

Parameter		Value
Scavenging coefficient	Liquid precipitation	0.0001 s^{-1}
	Frozen precipitation	0.00003 s^{-1}
Particle size distribution	Geometric mean diameter	0.48 µm
	Geometric standard deviation	2.0 µm
Reference cuticle resistance		30 s/cm
Reference ground resistance		10 s/cm
Reference pollutant reactivity		8
# of particle-size intervals used to evaluate effective particle deposition velocity		9
Vegetation state in unirrigated areas		Active and unstressed vegetation

Table C.2: CALPUFF modeling technical options used in this study.

Option	Selected
Vertical distribution used in the near field	Gaussian
Terrain adjustment	Partial plume path adjustment
Subgrid-scale complex terrain	Not modeled
Near-field puffs modeled as elongated slugs	No
Transitional plume rise	Transitional rise computed
Stack tip downwash	Yes
Building downwash	No
Method used to compute plume rise for point sources not subject to building downwash	Briggs plume rise
Vertical wind shear modeled above stack top	No
Puff splitting	No
Gravitational settling (plume tilt)	No
Method used to compute dispersion coefficients	PG dispersion coefficients for rural areas; MP coefficients in urban areas
PG sigma (y, z) adjusted for roughness	No
Partial plume penetration of elevated inversion modeled for point sources	Yes
Strength of temperature inversion	Computed from measured/default gradients

Option	Selected
PDF used for dispersion under convective conditions	No
Subgrid TIBL module used for shoreline	No
Boundary conditions	No
Land-use categories for which urban dispersion is assumed	13

Appendix D – CALPUFF Results

The purpose of this appendix is to provide additional information on CALPUFF results and to present findings from selected model performance evaluations. Because observations at air monitoring stations include $PM_{2.5}$ contributions from all sources (not just Chevron), it is impossible to evaluate the model results against them. Therefore, we attempted to evaluate the model qualitatively. Examples provided include (1) examining the model's ability to capture monthly, seasonal, and year-to-year variability in concentration levels in response to changes in meteorological conditions; and (2) comparing CALPUFF results against simulations performed using a different model with the same inputs.

Figure D.1 shows the annual average CALPUFF-simulated $PM_{2.5}$ concentrations for 2016, 2017, and 2018 across the 100-m receptor domain. There are some variations in concentrations among these years, which are thought to be due to year-to-year variability in meteorological conditions.

First, the areal extent of concentrations between 0.1 µg/m^3 and 0.5 µg/m^3 is different among these years. In 2016 and 2018, concentrations in this bin reached further to the east (near Vallejo) and to the north (near American Canyon) compared with 2017, possibly due to stronger westerly winds during those years. In 2017, concentrations reached Treasure Island in the south while remaining to the north side of this island during 2016 and 2018, possibly due to stronger easterly winds in 2017.

In addition, monthly average $PM_{2.5}$ concentrations were calculated for each year, and the top five values within each month were then averaged to provide a representation of peak concentration levels. Differences in these top five monthly average concentrations were also evident among the three years, as shown in Figure D.2.

The model was able to capture differences among the same months across the years, as well as monthly variations within the same year. Differences among the same months across the years are significantly smaller than monthly variations within the same year. This is because vertical mixing is stronger during summer months, allowing more pollutants to reach ground level than in non-summer months.

Next, the number of receptors with annual average concentrations above 0.1 µg/m^3 was compared among the years, as shown in Table D.1. The number of receptors did not change significantly from year to year, indicating that while the shape of the emissions plume is different for each year due to year-specific meteorological conditions, the overall size of the area impacted does not change significantly.

Figure D.3 shows a close-up map of the 100-m receptor domain for 2016, 2017, and 2018. Areas covered by concentrations between 0.5 µg/m^3 and 1.0 µg/m^3 extend further toward the east side of Richmond Parkway in 2018 than in 2016 and 2017. This close-up map also shows that year-to-year variability in concentrations is captured by the model.

To further evaluate CALPUFF, we simulated $PM_{2.5}$ for 2016 using the SCICHEM model with the same emissions and meteorological inputs for that year. While exhibiting some differences due to different plume dynamics representations, results from the two models are qualitatively similar to each other, as shown in Figure D.4, confirming that the CALPUFF-simulated concentrations are reasonable.

For reference, we also plotted simulated annual average concentrations for 2016, 2017, and 2018 emissions from only the FCCU for the 100-m receptor domain (Figure D.5) and for a close-up of the 100-m domain (Figure D.6). Both sets of figures look reasonable.

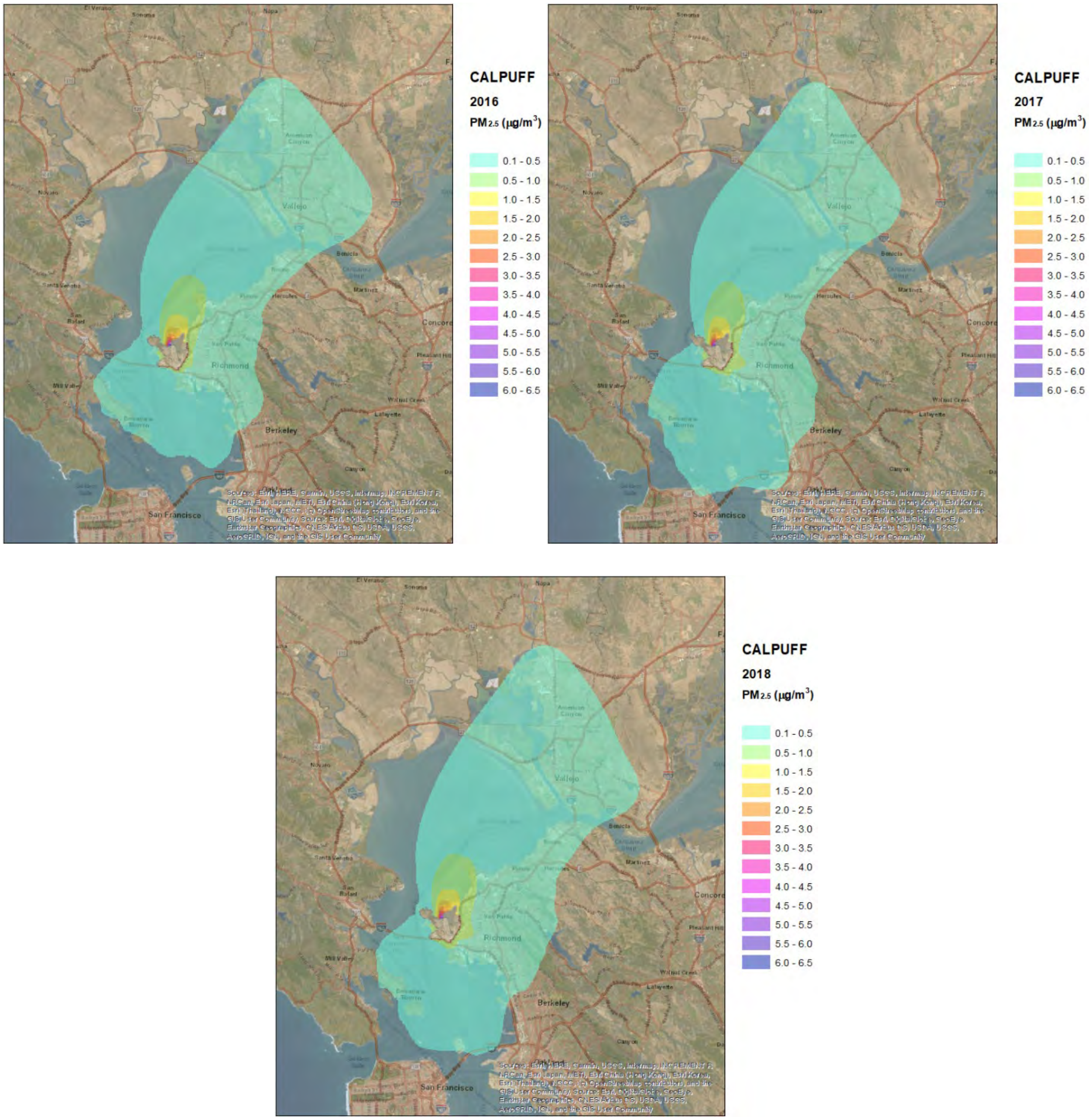


Figure D.1: Annual average CALPUFF-simulated $PM_{2.5}$ concentrations for the 100-m receptor domain for 2016, 2017, and 2018. $PM_{2.5}$ emissions from all (119) point sources were included in these simulations.

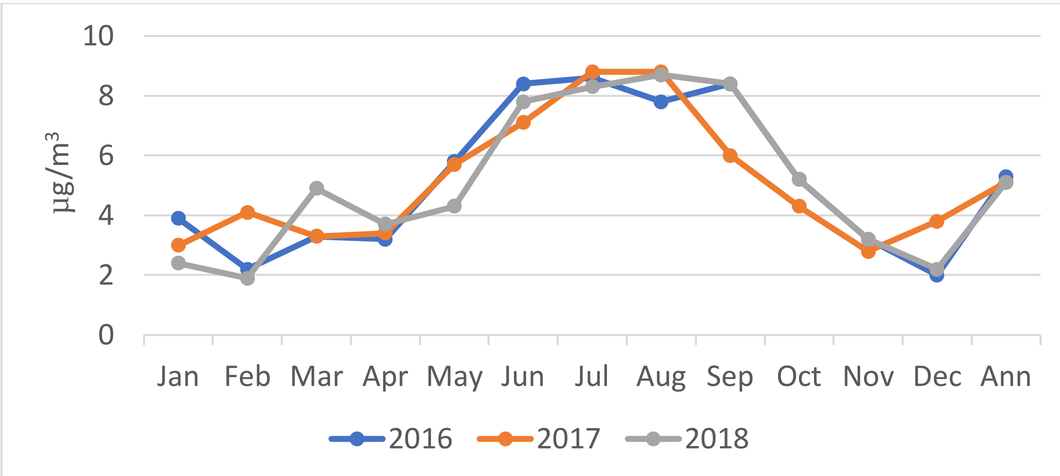


Figure D.2: Average of top five monthly average $PM_{2.5}$ concentrations for 2016, 2017, and 2018.

Table D.1: Number of 100-m receptors with CALPUFF-simulated annual average $PM_{2.5}$ concentrations above 0.1 µg/m^3.

2016	2017	2018
65,012	66,040	70,059

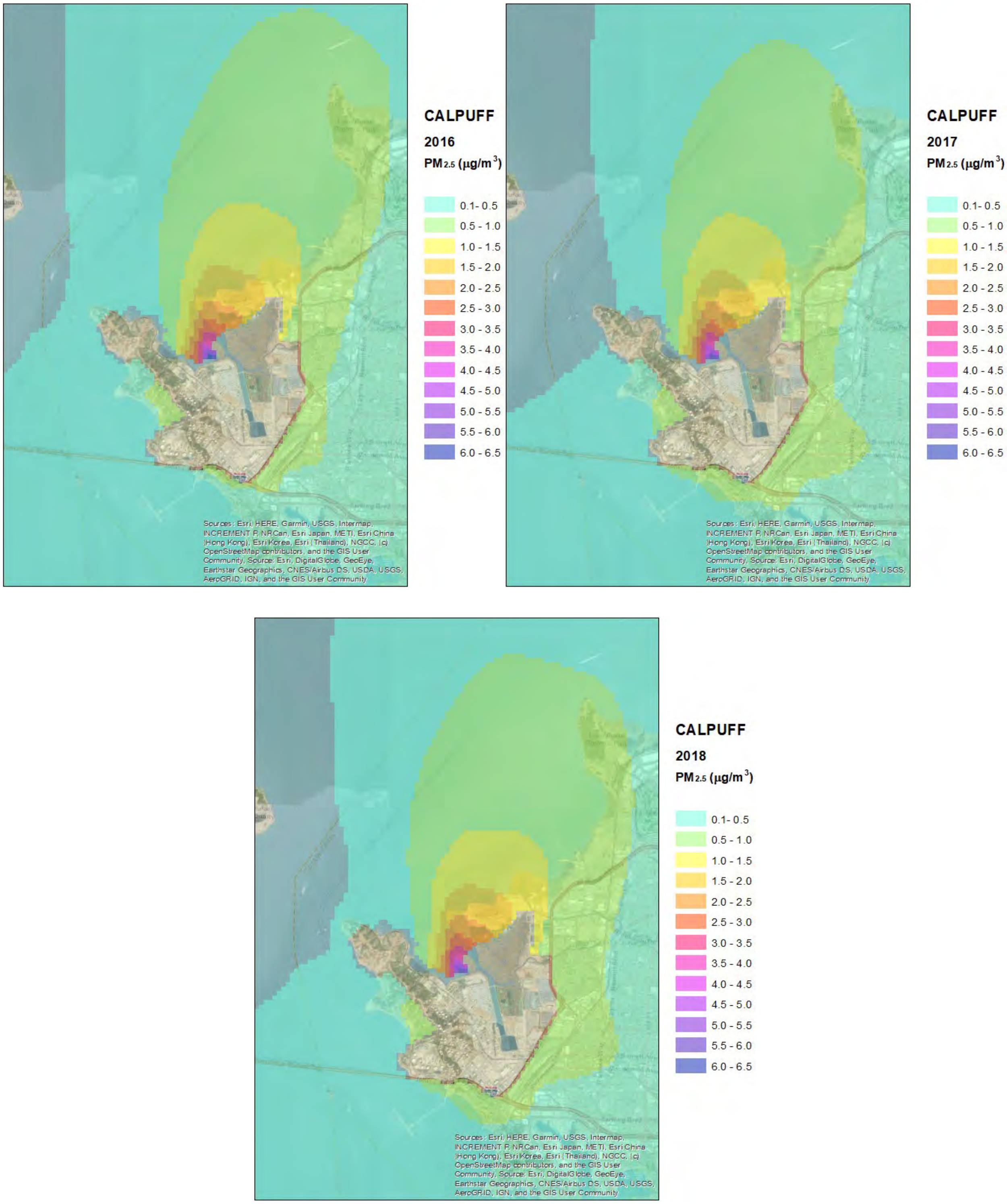


Figure D.3: Annual average CALPUFF-simulated $PM_{2.5}$ concentrations for 2016, 2017, and 2018 for a subset of the 100-m receptor domain that includes high-concentration areas. $PM_{2.5}$ emissions from all (119) point sources were included in these simulations.

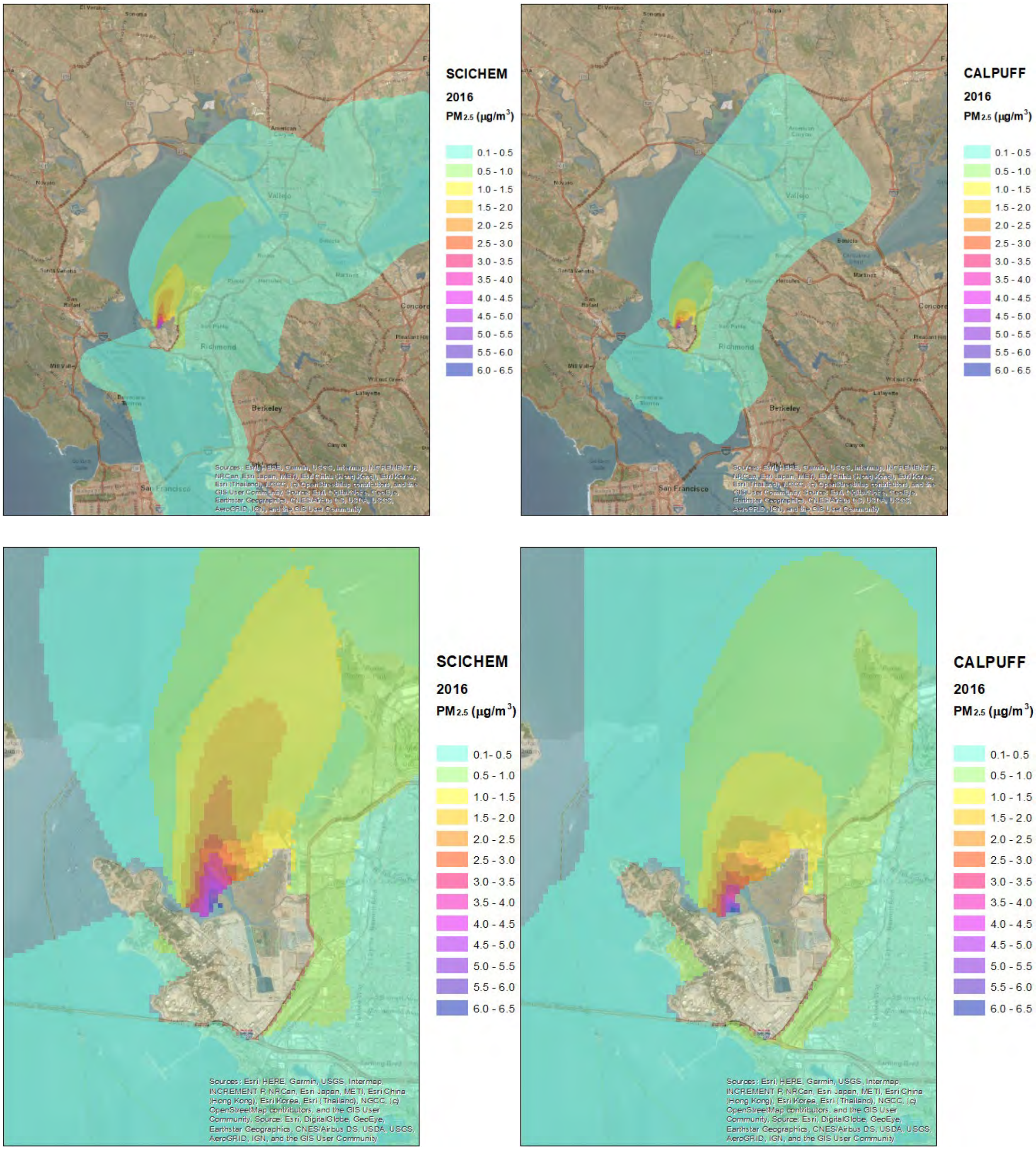


Figure D.4: Annual average $PM_{2.5}$ concentrations using SCICHEM and CALPUFF for 2016. Upper panels show the entire 100-m receptor domain and lower panels show a subset of high-concentration areas within the 100-m domain. Emissions from all (119) sources were included in these simulations.

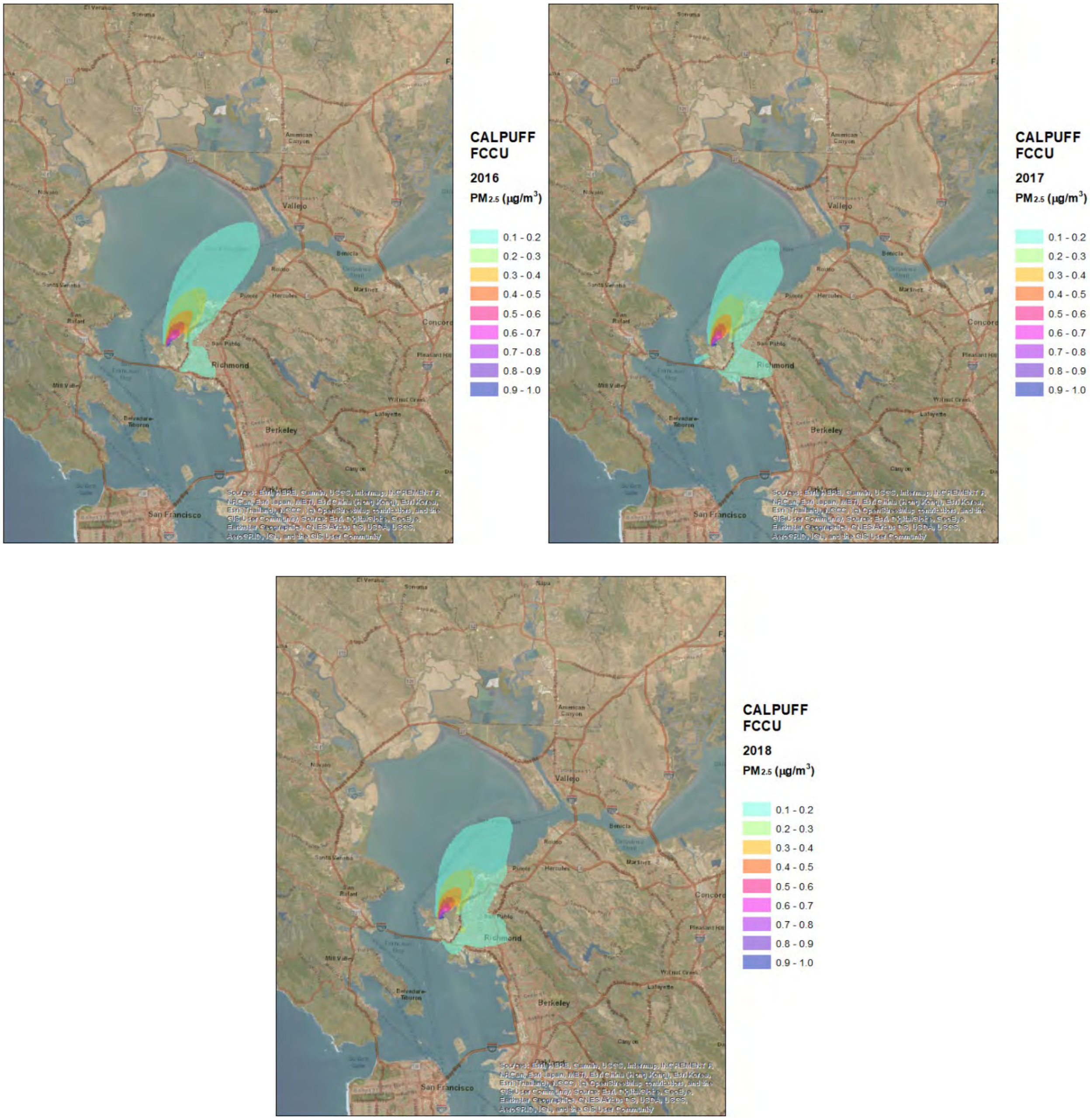


Figure D.5: Annual average CALPUFF-simulated $PM_{2.5}$ concentrations for the 100-m receptor domain for 2016, 2017, and 2018. $PM_{2.5}$ emissions from the FCCU only (without a WGS) were included in these simulations.

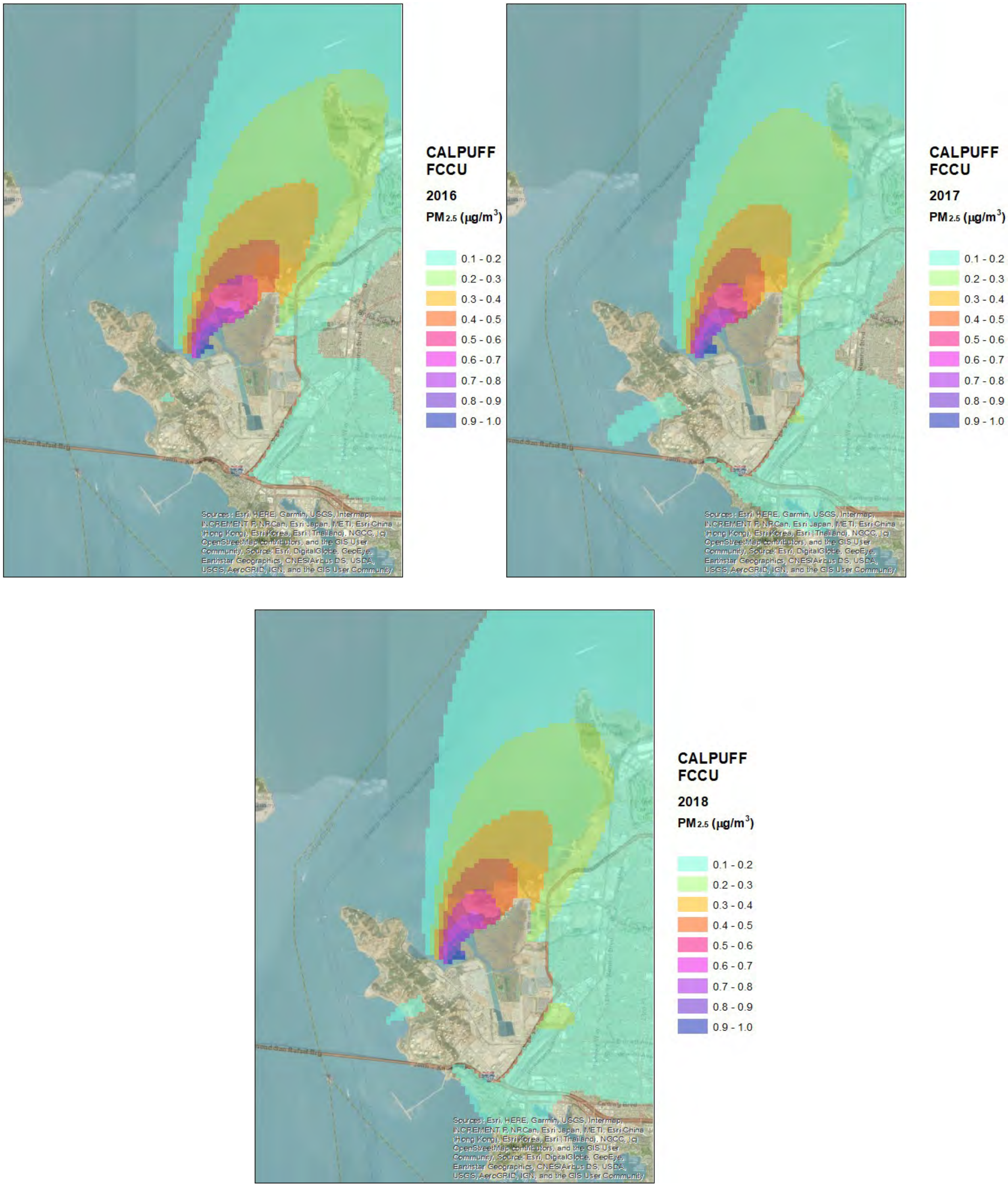


Figure D.6: Annual average CALPUFF-simulated $PM_{2.5}$ concentrations for 2016, 2017, and 2018 for a subset of the 100-m receptor domain that includes high-concentration areas. $PM_{2.5}$ emissions from the FCCU only (without a WGS) were included in these simulations.

Appendix A.5:

Modeling Fine Particulate Matter Emissions from the PBF Martinez Refinery: An Air Quality Analysis (Version 2)

Version 2 promoted to final from interim draft.

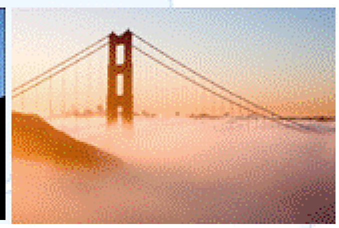
Changes since version 1: Appendix A.5 reordered within Appendix A.

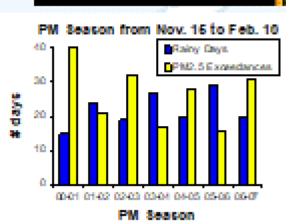
BAY AREA AIR QUALITY MANAGEMENT DISTRICT
375 Beale Street, San Francisco, CA 94105

Air Quality Modeling and Analysis Section Publication No. 202103-021-PM

Modeling Fine Particulate Matter Emissions From the PBF Martinez Refinery: An Air Quality Analysis (Version 2)

March 2021





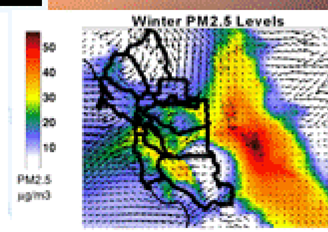


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Table of Contents

Executive Summary

Introduction

Staff at the Bay Area Air Quality Management District (Air District or BAAQMD) are in the process of estimating contributions of directly emitted fine particulate matter ($PM_{2.5}$) from major industrial facilities in the Bay Area to ambient $PM_{2.5}$ levels. This report presents results from modeling analyses for the PBF refinery in Martinez, California. Results for the Chevron refinery have been previously reported, and those for other facilities are forthcoming. Analyses of human exposure to estimated $PM_{2.5}$ levels for each facility will be reported as they become available. The purpose of this effort is to provide technical information to supplement the Air District's rule development efforts and to support the Air District's assessments related to the implementation of Assembly Bill 617 (AB 617).

The California Puff (CALPUFF) model will be used for estimating ambient $PM_{2.5}$ levels contributed by major facilities. Emissions from each major facility will be separately simulated using CALPUFF. Two sets of receptor domains will be established. One will cover the entire Bay Area at 1-km grid resolution, and the other will cover areas with simulated $PM_{2.5}$ concentrations above 0.1 µg/m^3 at 100-m grid resolution.

CALPUFF will be applied for three years (2016, 2017, and 2018) using year-specific meteorology and the same base-year (2018) emission estimates. Average results from the three annual simulations will be used for analyses to minimize the impact of year-to-year variability in meteorology on ambient $PM_{2.5}$ levels.

CALPUFF requires an emissions input file that includes detailed information for each modeled source, including source ID number, location coordinates, base elevation, stack height, stack diameter, gas exit velocity, gas exit temperature, and emission rate. There were 63 release points identified for the $PM_{2.5}$ emissions at the PBF refinery and an estimated total (in 2018) of 463 tons of $PM_{2.5}$ emitted annually. The single largest source, the fluid catalytic cracking unit (FCCU), is responsible for about two-thirds (65%) of the annual $PM_{2.5}$ emissions.

It should be noted that all emissions and stack parameter data represent the best available information at the time the modeling was conducted. Prior to modeling, quality control (QC) checks were performed on the stack-level data. For example, source locations were plotted and reviewed. In addition, minimum and maximum values for each stack parameter were identified to make sure that all values fell within reasonable bounds.

Meteorological inputs to CALPUFF were prepared using the Weather Research and Forecasting (WRF) model. The WRF model was tested using available options for physics and dynamics, as well as the datasets used to initialize and drive the model. Results of each test were evaluated, and the best-performing set of options was selected for final modeling.

Results

Simulation results are presented for three different emissions scenarios: emissions from (1) all point sources, (2) FCCU only, and (3) FCCU with an assumed wet gas scrubber. Key findings are tabulated, illustrated, and discussed below.

Simulations with Emissions from All Sources

Figure ES.1 shows the three-year (2016–2018) average CALPUFF-simulated $PM_{2.5}$ concentrations for the 100-m receptor domain. Estimated concentrations within the PBF facility fence line and concentrations below 0.1 µg/m^3 are not shown.

CALPUFF estimates concentrations at receptor points located at the center of each 100 x 100 m grid cell. For mapping purposes, each grid cell is color coded based on the concentration value at its center. An interval of 0.5 µg/m^3 was selected for color coding (except for concentrations between 0.1 µg/m^3 and 0.5 µg/m^3).

As can be seen in Figure ES.1a, the lowest concentration bin (0.1 µg/m^3 to 0.5 µg/m^3) extends from Pleasant Hill in the south to Birds Landing in the north and from Pinole Valley in the west to Decker Island in the east. The emissions plume has an elongated shape in the southwesterly and northeasterly directions from Martinez, consistent with predominant winter and summer wind patterns there, respectively.

The area with concentrations above 0.5 µg/m^3 is much smaller than the area covered by the lowest concentration bin, as described above. These higher concentrations are mostly confined to the area around the PBF facility and extend toward the northeast of the facility.

To better visualize the high-concentration areas, a zoomed-in map of the 100-m receptor domain was created (Figure ES.1b). As shown in this figure, an area with concentrations between 0.5 µg/m^3 and 1.0 µg/m^3 extends from the east side of the facility toward Port Chicago, between the southern bank of Suisun Bay and California Highway 4. There is also a small area with concentrations between 0.5 µg/m^3 and 1.0 µg/m^3 to the west of the PBF facility.

Concentrations above 1.0 µg/m^3 primarily lie to the east of the facility over an area that does not overlap residential zones in the region. In addition, a sharp concentration gradient is apparent near the facility fence line. The maximum concentration (3.8 µg/m^3) is located just outside the fence line.

Simulations with FCCU Emissions

CALPUFF was also run with emissions from only the FCCU for two scenarios: one with the baseline FCCU emissions, and the other with reduced FCCU emissions (and altered stack parameters) consistent with the installation of a wet gas scrubber (WGS). The resulting three-year average $PM_{2.5}$ concentrations are shown in Figure ES.2 (FCCU without WGS) and Figure ES.3 (FCCU with WGS installed). Again, concentrations within the facility fence line and below 0.1 µg/m^3 are not shown. An interval of 0.2 µg/m^3 was selected for color coding concentration values at grid cells.

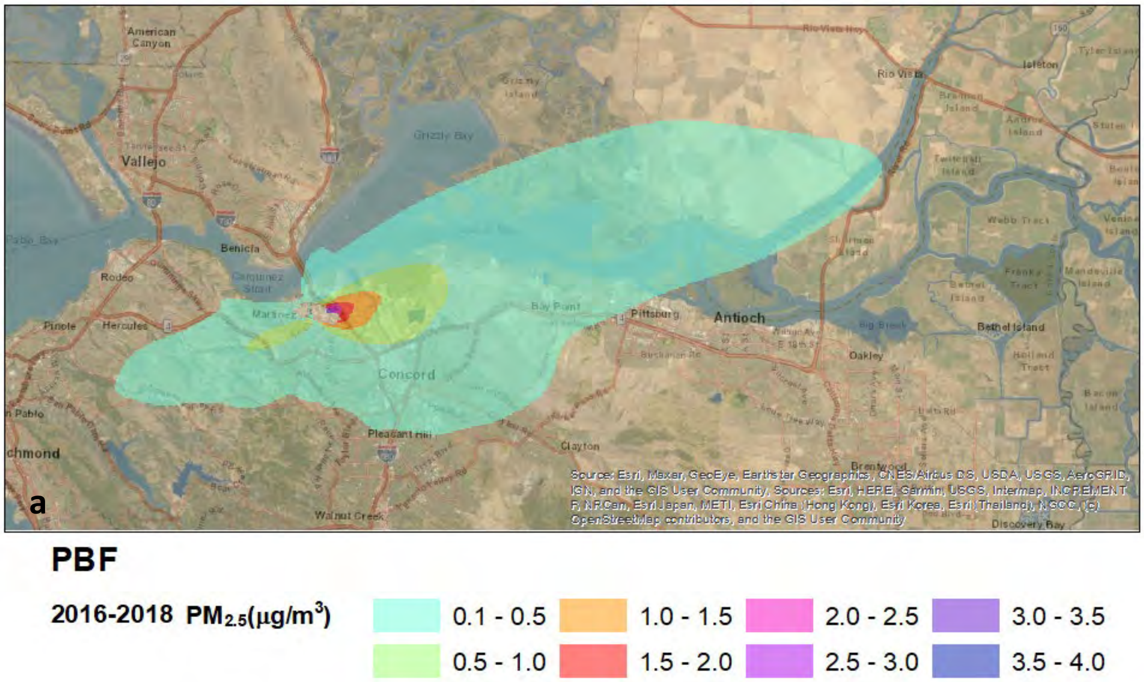
Emissions from this source are mainly transported to the southwest and northeast of the facility, similar to the all-source results, but with smaller impact areas: the number of sampling receptors (100-m grid) with three-year average concentrations above 0.1 µg/m^3 was reduced from 42,741 (all-source simulation) to 21,452 (FCCU-only simulation), i.e., a 50% reduction. The maximum three-year average concentration from this source is 2.0 µg/m^3, or about 53% of the maximum concentration from the all-source simulation. This is somewhat lower than the contribution of the FCCU to the total $PM_{2.5}$ emissions from the facility (65%).

Installation of a WGS further reduces the number of receptors with three-year average concentrations above 0.1 µg/m^3 to 1,078 (a 95% reduction from the baseline FCCU emission scenario) and reduces the maximum three-year average concentration to 0.46 µg/m^3 (22% of the maximum concentration from the baseline FCCU emission scenario). This reduction in the maximum concentration is consistent with the emission reduction by a WGS (78%), as the maximum concentration occurs close to the source location.

Table ES.1 shows the key findings of simulations with the three sets of emissions.

Table ES.1: Key findings of simulations with emissions from all point sources, FCCU only, and FCCU with assumed WGS. Results shown are for the 100-m receptor domain.

	Annual $PM_{2.5}$ emissions (tons/year)	**Maximum simulated concentrations (µg/m^3)**	**Number of sampling receptors with concentrations above 0.1 µg/m^3**
All point sources	463.20	3.8	42,741
FCCU only	299.61	2.0	21,452
FCCU with assumed WGS	65.91	0.46	1,078



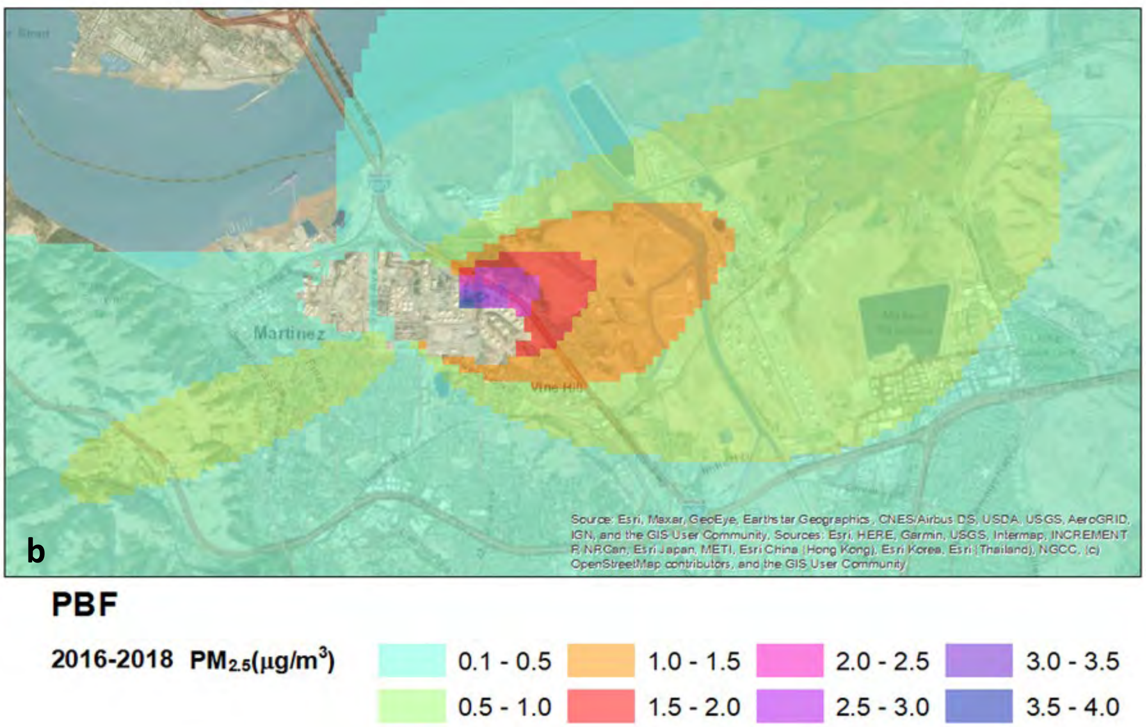


Figure ES.1: Three-year (2016–2018) average CALPUFF-simulated $PM_{2.5}$ concentrations for (a) the 100-m receptor domain, and (b) a zoomed-in area of high concentrations. Emissions from all PBF point sources are included in this simulation. Concentrations inside the PBF fence line and that are below 0.1 µg/m^3 are not shown.

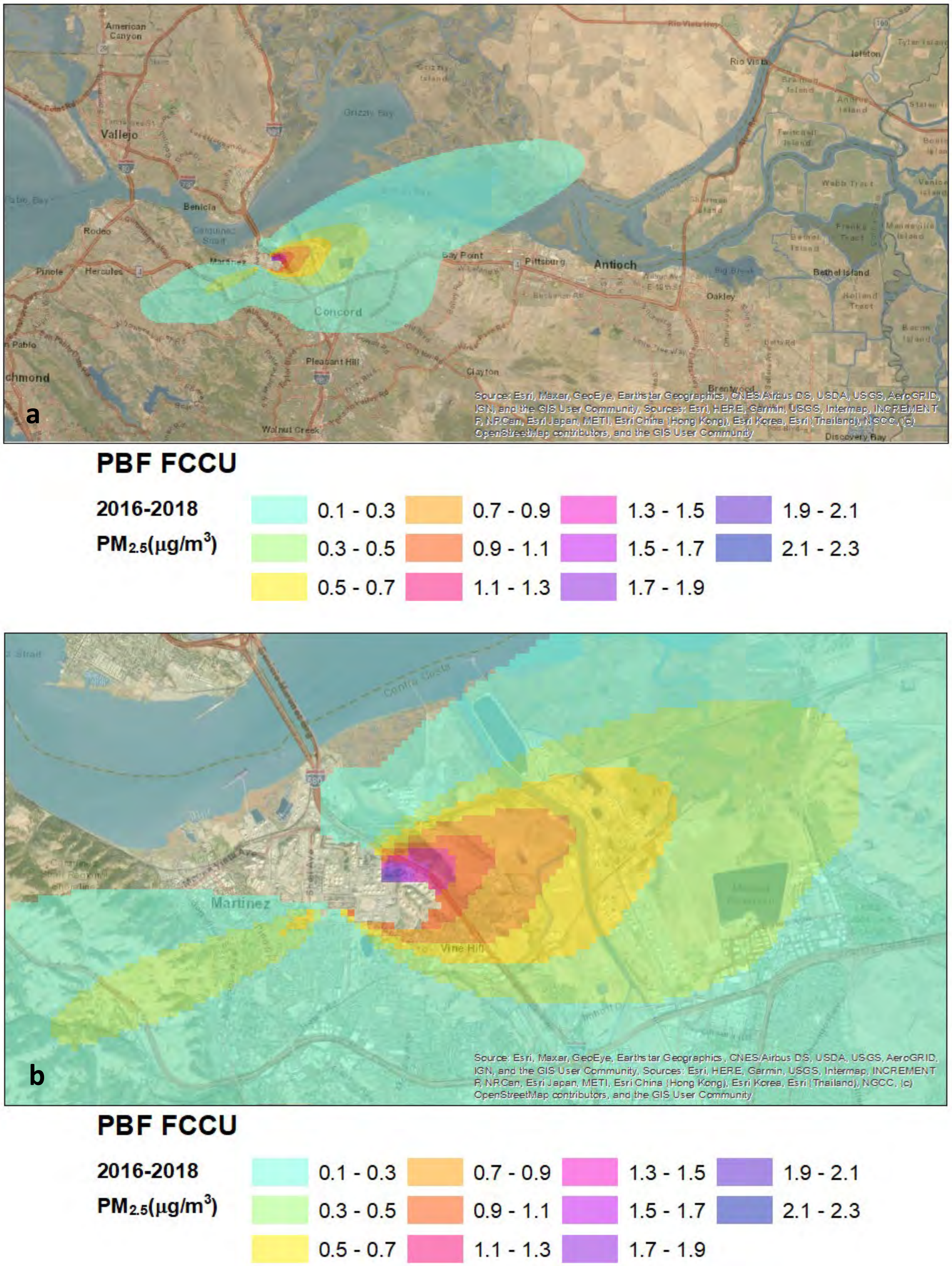


Figure ES.2: Three-year (2016–2018) average CALPUFF-simulated $PM_{2.5}$ concentrations for: (a) the 100-m receptor domain, and (b) a zoomed-in area of high concentrations. Emissions from the FCCU only (without a WGS) are included in these simulations. Concentrations inside the PBF fence line and that are below 0.1 µg/m^3 are not shown.

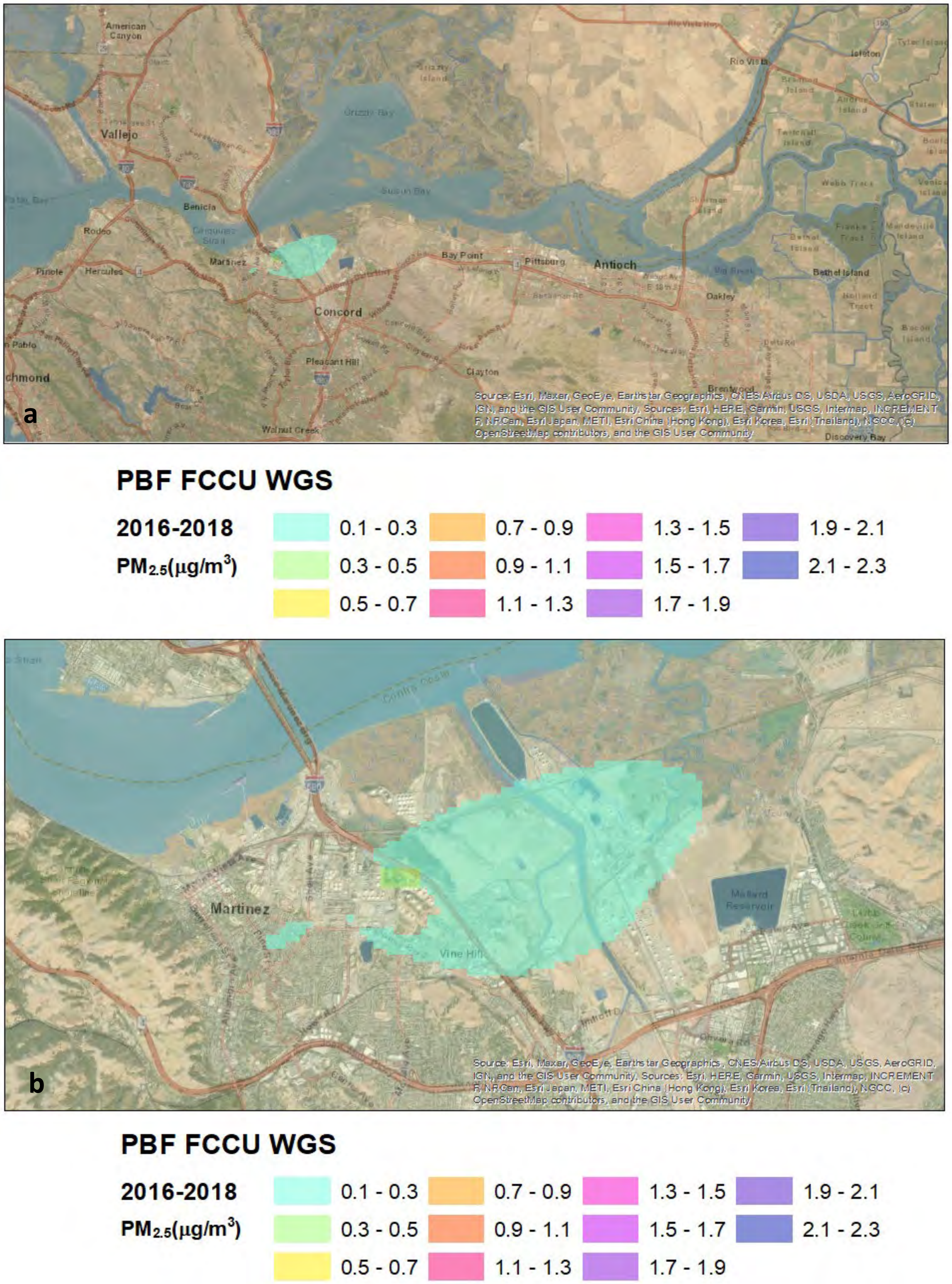


Figure ES.3: Three-year (2016–2018) average CALPUFF-simulated $PM_{2.5}$ concentrations for: (a) the 100-m receptor domain, and (b) a zoomed-in area of high concentrations. Emissions from the FCCU only (with an assumed WGS) are included in these simulations. Concentrations inside the PBF fence line and that are below 0.1 μg/m^3 are not shown.

List of Acronyms

AB 617	Assembly Bill 617
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
ASPEN	Assessment System for Population Exposure Nationwide (model)
BAAQMD	Bay Area Air Quality Management District
BenMAP-CE	Benefits Mapping and Analysis Program-Community Edition
CALPUFF	California Puff (model)
CAMx	Comprehensive Air Quality Model with Extensions
CARB	California Air Resources Board
CFR	Code of Federal Regulations
CMAQ	Community Multiscale Air Quality (model)
EPA	Environmental Protection Agency
FCCU	Fluid Catalytic Cracking Unit
FDDA	Four-Dimensional Data Assimilation
FLM	Federal Land Manager
GMT	Greenwich Mean Time
GR/DSCF	Grains per Dry Standard Cubic Feet
IOA	Index of Agreement
ISCST3	Industrial Source Complex Short Term 3 (model)
MMIF	Mesoscale Model Interface
PDF	Probability Distribution Function
PG	Pasquill–Gifford
$PM_{2.5}$	Particulate Matter 2.5 micrometers or less in diameter
PST	Pacific Standard Time
QA	Quality Assurance
QC	Quality Control
RMSE	Root Mean Square Error
SCICHEM	Second-order Closure Integrated Puff with Chemistry (model)
SRDT	Solar Radiation/Delta-T
TIBL	Thermal Internal Boundary Layer
UTM-TOX	Urban Airshed Model for Toxics
WGS	Wet Gas Scrubber
WOEIP	West Oakland Environmental Indicators Project
WRF	Weather Research and Forecasting (model)

Modeling Fine Particulate Matter Emissions From the PBF Martinez Refinery: An Air Quality Analysis (Version 2)

1 Introduction

1.1 Background

The adoption of Assembly Bill 617 (AB 617) established collaborative programs to reduce community exposure to air pollutants in neighborhoods most impacted by air pollution. Air District staff have been working closely with the California Air Resources Board (CARB), other state agencies, local air districts, community groups, community members, environmental organizations, regulated industries, and other key stakeholders to reduce harmful air pollutants in Bay Area communities.

As part of these programs, staff at the Bay Area Air Quality Management District (Air District or BAAQMD) plan to estimate contributions of directly emitted fine particulate matter ($PM_{2.5}$) from major industrial facilities in the Bay Area to ambient $PM_{2.5}$ levels. Staff will then analyze human exposure to resulting $PM_{2.5}$ levels. The California Puff (CALPUFF) model (Version 6.42; Exponent, 2011) will be used for estimating ambient $PM_{2.5}$ levels contributed by major facilities.

Emissions from each major facility will be separately simulated using CALPUFF. Two sets of receptor domains will be established. One will cover the entire Bay Area at 1-km grid resolution and the other will cover areas with concentrations above 0.1 µg/m^3 at 100-m grid resolution.

CALPUFF will be applied for three years (2016, 2017, and 2018) using year-specific meteorology and the same base-year (2018) emission estimates. Average results from the three annual simulations will be used for analyses to minimize the impact of year-to-year variability in meteorology on ambient $PM_{2.5}$ levels. The model estimates hourly concentrations at each receptor location, and these hourly values are then aggregated into daily, monthly, and annual averages. Concentrations estimated for these averaging periods will be analyzed for the purpose of model evaluation; however, only annual and three-year average concentrations will be presented in modeling reports for each facility.

CALPUFF is an advanced puff model originally developed for CARB (under the management of Saffet Tanrikulu, currently a District manager) to simulate pollutants emitted from major facilities and roadways in a complex terrain environment. CALPUFF was adopted by the U.S. Environmental Protection Agency (EPA) in 2003 as a “preferred” dispersion model, becoming one of the most widely used models for studying pollutant dispersion and transport in the U.S. and worldwide. However, in 2017, CALPUFF was removed from the U.S. EPA’s “preferred model” list due to concerns about its ability to handle long-range pollutant transport. Because the main goal of our project is to assess impacts of pollutants relatively near their sources, the U.S. EPA's concern is not relevant to our application of the model.

This report will present results from the application of CALPUFF to emissions from the PBF refinery in Martinez. Results for the Chevron refinery have previously been reported. CALPUFF applications for other Bay Area refineries and the Lehigh Cement factory are under way, and results from those simulations will be reported in subsequent documents.

1.2 Model Selection and Modeling Strategy

Air District staff have applied the U.S. EPA's Community Multiscale Air Quality (CMAQ) model (EPA, 1999) to estimate regional $PM_{2.5}$ and air toxics concentrations in the Bay Area (Tanrikulu et al., 2019). Because of limitations in its internal parameterization, this model is typically applied at 1-km or coarser grid resolutions. CMAQ has a plume-in-grid module for handling diffusion and dispersion of pollutants emitted from large point sources at subgrid scales. This plume-in-grid module employs a modified version of the Second-order Closure Integrated Puff with Chemistry (SCICHEM) model (Karamchandani et al., 2014).

One advantage of applying CMAQ with the plume-in-grid module is the ability to simultaneously simulate $PM_{2.5}$ at regular grid resolutions as well as subgrid resolutions. The plume-in-grid module in CMAQ was tested for the Bay Area modeling domain at 1-km grid resolution but failed to complete the test due to prohibitively large computational cost (Tanrikulu et al., 2019). Troubleshooting the model was not feasible within this project schedule; however, as a corroborative analysis, we applied the stand-alone version of SCICHEM (Version 3.2.2; EPRI, 2019) for simulating impacts of $PM_{2.5}$ emissions from the Chevron refinery, and its results were compared against results obtained from CALPUFF. This analysis was documented in our previous report on the modeling study for the Chevron refinery. Results from the two models largely agree with each other. It is also documented in (Koo et al., 2020).

Air District staff have applied another dispersion model (AERMOD) for simulating $PM_{2.5}$ emissions from local sources to assess their impacts on community-scale $PM_{2.5}$ levels. Most recently, AERMOD was applied for a wide variety of emission sources in West Oakland (BAAQMD and WOEIP, 2019). The model is also used by the District to evaluate permit applications. AERMOD utilizes meteorological information, such as wind speed and direction, at or close to source locations only. This is a significant shortcoming of the model when it is used to simulate elevated point source emissions that can travel to downwind locations where near-source meteorological information is no longer representative.

The CALPUFF model is specifically designed to utilize meteorological information over the entire area where a plume is expected to travel. Therefore, CALPUFF is more suitable for simulating $PM_{2.5}$ from the major point sources identified for this project.

CALPUFF has been applied in the Bay Area by the Air District as well as CARB to support several prior projects. In 2008, CARB, in collaboration with the Air District, conducted a health risk assessment study to evaluate the potential public health impacts of diesel $PM_{2.5}$ emissions in West Oakland (CARB, 2008). To estimate ambient $PM_{2.5}$ levels, the project team considered several air dispersion models, such as ISCST3, AERMOD, ASPEN, CALPUFF, UTM-TOX, and CAMx. CALPUFF was selected because of its ability to handle complex terrain impacts and better treat various emission sources at fine scales. In 2017, CALPUFF was used for a collaborative demonstration project by the Air District and U.S. EPA that assessed the impact of $PM_{2.5}$ precursor emissions in the Bay Area (BAAQMD, 2017).

CALPUFF can be run with two different domains: (1) a computational domain, and (2) a receptor domain. In the computational domain, the model calculates plume dynamics using input parameters such as emissions, as well as gridded meteorological, land use and terrain elevation data. In the receptor domain, the model samples estimated concentrations at specified receptor points. Receptor points can be either gridded, where the model samples concentrations at the center of each grid cell or placed at discrete locations specified by the user. In general, gridded receptors are used for large, facility-impacted areas and discrete receptors are used for sensitive locations such as hospitals, schools, facility fence lines, etc.

As mentioned above, for the purpose of this study, we defined two sets of gridded receptors surrounding the facility and ran the model sequentially for both sets. The first set of receptors covered the entire Bay Area at 1-km grid resolution. A second set of 100-m resolution receptors covered areas with annual average $PM_{2.5}$ levels above 0.1 $\mu g/m^3$, as identified from the 1-km simulation.

1.3 Exposure Analysis

Simulated concentrations show contributions of emissions to ambient $PM_{2.5}$ levels but do not provide information on human exposure to this pollutant. Human exposure to $PM_{2.5}$ is one of the parameters used by air quality planners, the AB 617 technical assessment team, and rule developers in their analyses.

Exposure refers to any contact between an airborne contaminant and a surface of the human body, either outer (such as the skin) or inner (such as respiratory tract epithelium). Therefore, exposure requires the simultaneous occurrence of two events: a pollutant concentration at a particular place and time, and the presence of a person at that place and time (Ott, 1985).

To estimate population exposure, both concentrations and population data are needed. For this purpose, we will use average simulated $PM_{2.5}$ concentrations for 2016–2018 as the pollutant concentration estimate. Population data will be downloaded from the U.S. Census Bureau for 2010[1] and projected to 2018 using U.S. EPA's Benefits Mapping and Analysis Program-Community Edition (BenMAP-CE Version 1.5; EPA, 2018). Demographic data with socioeconomic information will be used to address disparity issues such as environmental inequality. Results from the exposure analysis will be provided in an accompanying report.

[1] https://www2.census.gov/census_2010/04-Summary_File_1/

1.4 Analysis of Representativeness

$PM_{2.5}$ levels in the Bay Area can vary significantly from year to year due to variable weather patterns and the associated variations in pollutant transport. To account for year-to-year variability in modeled concentrations, we simulated three consecutive years (2016–2018) for this project. This will increase the representativeness of simulated $PM_{2.5}$ levels.

Although we did not conduct a comprehensive meteorological representativeness study, simulating three recent years should increase the representation of meteorology across multiple years and is consistent with EPA's Guideline on Air Quality Models (40 CFR Part 51), where the use of multiple years of meteorological data (up to five) is recommended to ensure worst-case conditions are sufficiently characterized in regulatory modeling applications.

2 Modeling Methods

2.1 Emissions Inventory Preparation

CALPUFF requires an emissions input file that includes detailed information for each modeled source, including source ID number, location coordinates, base elevation, stack height, stack diameter, gas exit velocity, gas exit temperature, and emissions rate. This section describes the datasets and processes used to develop CALPUFF-ready emissions inputs for the PBF refinery.

To support the implementation of District Regulation 11, Rule 18 (11-18): Reduction of Risk from Air Toxic Emissions at Existing Facilities (BAAQMD, 2018), the District has begun collecting updated stack parameter information from permitted sources in the Bay Area. In addition, updated emission estimates for permitted facilities are being collected and reviewed under Regulation 12, Rule 15 (12-15, Petroleum Refining Emissions Tracking). Using information collected under these regulations, the Air District's Engineering Division developed and shared updated data for the PBF refinery to support CALPUFF modeling.

The Air District's Modeling and Analysis Section identified 63 unique point sources that emit $PM_{2.5}$ at PBF and worked with the Engineering Division to map all $PM_{2.5}$ emissions to the proper release points with their associated stack characteristics. Because multiple emission sources are often routed to a common stack, a total of 37 unique release points were modeled at PBF. It should be noted that all emissions and stack parameter data represent the best available information at the time the modeling was conducted.

Prior to modeling, quality control (QC) checks were performed on the stack-level data. For example, source locations were plotted and reviewed. Minimum and maximum values for each stack parameter were also identified to make sure that all values fell within reasonable bounds (see Appendix A). In a few cases, stack parameters were flagged, reviewed with staff from the Engineering Division, and updated based on their feedback. After QC checks were complete, emissions and stack parameters for each modeled source were converted to a CALPUFF-ready format using a Python script developed by the Modeling and Analysis Section.

Note that CALPUFF utilizes grid averaged terrain data provided through its meteorological input from the Weather Research and Forecasting (WRF) model. The base elevation for each source provided usually does not match grid averaged terrain elevation, and if these base elevations are used, some short stacks could be represented as emitting at or below ground level. A similar problem arises if the actual elevations of receptors are used rather than grid averaged terrain elevations. For example, receptors with elevations below the grid averaged terrain elevations are erroneously treated as underground receptors. To maintain consistency among source, receptor, and terrain elevations in CALPUFF, the base elevations were replaced with the WRF grid averaged terrain elevations, and grid averaged terrain elevations were also used for receptors.

Table 2.1.1 provides a summary of $PM_{2.5}$ emissions and stack parameters for all $PM_{2.5}$ sources at the PBF refinery. Annual $PM_{2.5}$ emissions from the facility total 463 tons. The single largest source, the fluid catalytic cracking unit (FCCU), is responsible for 65% of the annual $PM_{2.5}$ emissions (300 tons). The table also includes both the original base elevation data and the values from the WRF model grid averaged terrain data that were ultimately used for modeling.

Figure 2.1.1 shows the location of all 37 release points modeled in CALPUFF. The location of the FCCU is also identified in this figure (FCCU emissions are routed to three nearby stacks).

This study also evaluated the potential impact of installing a wet gas scrubber (WGS) on the FCCU at PBF. This type of control equipment not only reduces PM emissions, but also alters the release characteristics of the emissions plume. To develop adjusted emissions and stack parameters for the FCCU with an assumed WGS for modeling purposes, staff from the District’s Rule Development section reviewed source test data from other refineries. The goal of this review was to identify facilities with FCCU exhaust flow rates similar to the FCCU exhaust stacks at the PBF refinery, and that have WGS devices installed on the FCCU. Staff located four facilities with source test data to support this analysis:

- Hovensa Refinery, US Virgin Islands: test data from a US EPA 2011 Refinery Sector Information Collection Request
- Marathon Refining, Garyville, LA: 2017–2019 source test reports from the Louisiana Department of Environmental Quality’s Electronic Document Management System
- Marathon Refining, Galveston Bay, TX: 2016 source test report from the Texas Commission on Environmental Quality’s Central Registry
- Valero Refinery, Benicia, CA: 2016–2018 source test review memos from BAAQMD

Stack parameters for WGS-equipped FCCUs at these four facilities are shown in Table 2.1.2, along with average values across all these facilities. These average parameters were used to model FCCU emissions for the WGS control case, with all emissions routed to a single stack rather than the 3 stacks used to model FCCU emissions in the baseline scenario. This approach was used because it was assumed that the installation of a WGS would result in a single release point for controlled FCCU emissions. The location of the central FCCU stack from the baseline scenario (Source S-1509 in Table 2.1.1) was used to represent this single stack for the WGS control case. In addition, a control factor of 78% was applied to PBF's baseline FCCU emissions, reducing annual $PM_{2.5}$ emissions from 300 tons to 66 tons. This control factor for $PM_{2.5}$, also provided by the District's Rule Development section, was based on an emission limit of 0.010 grains per dry standard cubic feet (gr/dscf).

Table 2.1.1: Stack parameters and $PM_{2.5}$ emissions for all $PM_{2.5}$ sources at PBF.

Source ID	Source Description	Base Elevation (m)	Gridded Terrain Elevation (m)	Stack Height (m)	PM2.5 Emissions (tons/year)	Contribution to $PM_{2.5}$ Emissions
S-1426	FCCU – Stack 1	16.45	18.39	49.38	99.87	21.6%
S-1426	FCCU – Stack 2	16.41	18.39	49.38	99.87	21.6%
S-1426	FCCU – Stack 3	16.41	18.39	49.38	99.87	21.6%
—	***FCCU Total***				***299.61***	***64.7%***
S-1507	CO Boiler #1*	16.45	18.39	49.38	4.38	0.9%
S-1509	CO Boiler #2*	16.41	18.39	49.38	3.97	0.9%
S-1512	CO Boiler #3*	16.41	18.39	49.38	4.33	0.9%
S-1486	F40 Heater (Chimney 1)	16.44	18.39	107.00	25.11	5.4%
S-1487	F41B Heater (Chimney 1)					
S-1488	F41A Heater (Chimney 1)					
S-1490	F43 Heater (Chimney 1)					
S-1491	F44 Heater (Chimney 1)					
S-1492	F45 Heater (Chimney 1)					
S-1493	F46 Heater (Chimney 1)					
S-1494	F-47/DH Heater (Chimney 1)					
S-1495	F49 Heater (Chimney 1)					
S-1496	F50 Heater (Chimney 1)					
S-1497	F51 Heater (Chimney 1)					
S-1498	F52 Heater (Chimney 1)					
S-1499	F53 Heater (Chimney 1)					
S-4161	H-101/HP3 Individual Heater	7.40	10.36	61.00	23.22	5.0%
S-4192	CTG2 Turbine	16.40	18.39	74.00	21.17	4.6%
S-4193	Heat Recovery Steam Generator #2					
S-4190	CTG1 Turbine	16.42	18.39	74.00	19.71	4.3%
S-4191	Heat Recovery Steam Generator #1					
S-1500	F55 Heater (Chimney 2)	16.47	18.39	107.00	11.30	2.4%
S-1502	F57 Heater (Chimney 2)					

S-1503	F58 Heater (Chimney 2)					
S-1504	F59 Heater (Chimney 2)					
S-1505	F60 Heater (Chimney 2)					
S-1515	DH F-71 HCU First-Stage Reboil (Chimney 2)					
S-1761	F-104/OPCEN Individual Heater	23.93	10.36	55.00	10.17	2.2%
S-1457	LOP Cooling Tower	14.63	18.39	20.58	9.15	2.0%
S-1778	OPCEN Cooling Tower	21.95	10.36	20.58	5.32	1.1%
S-1501	F56 Thermal Oxidizer	16.41	18.39	107.00	5.27	1.1%
S-1506	F-61/CP Individual Heater					
S-1508	F-63/CP Individual Heater					
S-1510	F-66/CP Individual Heater					
S-1511	F-67/CP Individual Heater					
S-1517	F77 Thermal Oxidizer					
S-4002	F-13425A/DCU Individual Heater	8.16	10.36	76.00	3.71	0.8%
S-4003	F-13425B/DCU Individual Heater					
S-1763	F-126/DH Individual Heater	16.50	18.39	67.00	3.55	0.8%
S-1771	Flexigas Flare	24.02	10.36	23.00	2.34	0.5%
S-1760	F102/OPCEN Individual Heater	24.09	18.39	46.00	2.29	0.5%
S-1762	F-128/DH Individual Heater	16.47	18.39	57.00	1.88	0.4%
A-100	MVR_ThermOx Individual Heater	0.45	10.25	14.94	1.07	0.2%
S-4210	DCD Cooling Tower	6.40	18.39	20.58	0.80	0.2%
S-4021	F-13909/DHT Individual Heater	8.24	18.39	46.02	0.72	0.2%
A-4181	F14610 Thermal Oxidizer	23.93	18.39	46.00	0.66	0.1%
S-4031	HGHT-Reboiler Heater (F-14012)	8.12	18.39	46.00	0.62	0.1%
S-4141	HGHT-Feed Heater (F-14011)					
S-601	Vapor Recover 2 Flare	9.54	15.31	21.34	0.58	0.1%
S-1470	LPG Flare	8.69	10.25	25.00	0.56	0.1%
S-6051	Diesel Engine, emergency standby	10.01	18.39	2.44	0.54	0.1%
S-6073	Portable Emergency Standby Diesel Fire Pump Engine	21.22	10.36	3.20	0.27	0.1%
A-2023	F109 Thermal Oxidizer	23.88	18.39	46.00	0.16	0.0%

S-6054	Diesel Engine, emergency standby	38.83	20.53	2.44	0.14	0.0%
S-4201	Clean Fuels Flare	12.94	10.36	10.00	0.14	0.0%
S-6052	Diesel Engine, emergency standby	34.21	20.53	2.44	0.13	0.0%
S-1471	LOP Flare	8.64	18.39	15.00	0.13	0.0%
S-6053	Diesel Engine, emergency standby	8.48	15.31	2.44	0.09	0.0%
S-603	Vapor Recover 1 Flare	17.78	18.39	19.81	0.05	0.0%
S-1772	OPCEN Flare	24.00	10.36	31.00	0.02	0.0%
S-602	Vapor Recover 3 Flare	12.59	18.39	13.72	0.02	0.0%
S-4005	DCU Coke Loading	8.30	10.36	18.59	0.01	0.0%
S-1481	F30/F31 OPCEN Individual Heater	26.63	18.39	12.00	0.00	0.0%
	Totals				**463.20**	**100.0%**

* Emissions from the CO boilers are routed to the same three stacks that the FCCU emissions are split across; therefore, total emissions from these three stacks are 312 tons/year (300 tons/year from the FCCU and 12 tons/year from the CO boilers).

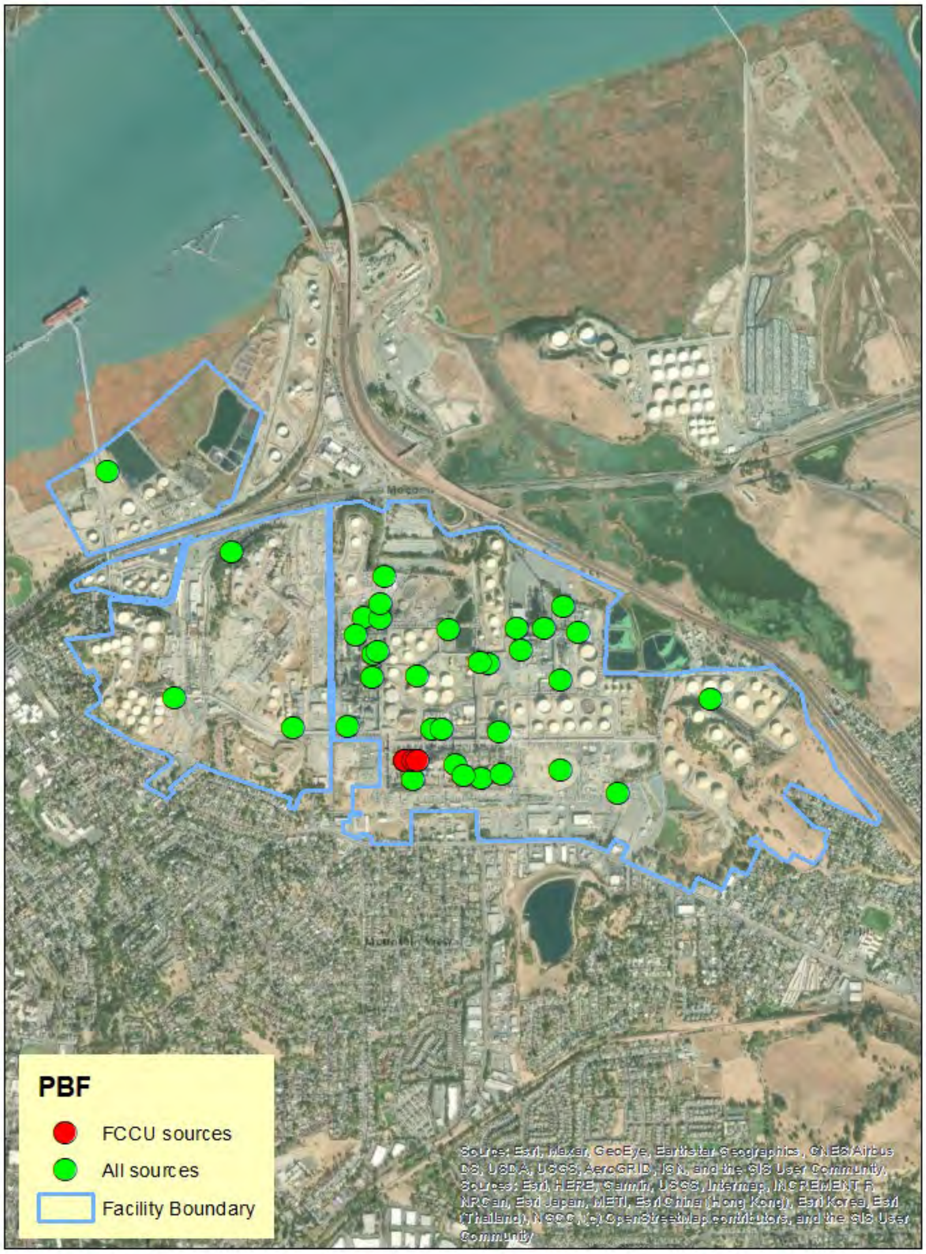


Figure 2.1.1: Locations of all 37 unique release points modeled at PBF. FCCU emissions are routed to three nearby stacks (shown in red).

Table 2.1.2: Stack parameters for a FCCU with a WGS installed.

Facility	Stack Diameter (m)	Stack Height (m)	Stack Temperature (°K)	Exit Velocity (m/sec)
Hovensa Refinery, US Virgin Islands (2011)	3.35	69.34	333.71	20.09
Marathon Refining, Garyville, LA (2017–2019)	3.96	68.88	337.76	11.87
Marathon Refining, Galveston Bay, TX (2016)	4.21	82.60	350.37	16.29
Valero Refinery, Benicia, CA (2016–2018)	—	73.00	326.48	—
Average	**3.84**	**73.46**	**337.08**	**16.08**

2.2 Meteorological Modeling

The WRF model (Version 4.1; Skamarock et al., 2019) was used to prepare meteorological inputs to CALPUFF. Four nested domains were used (Figure 2.2.1). The outer domain covered the entire western United States at 36-km horizontal grid resolution to capture synoptic (large-scale) flow features and the impact of these features on local meteorology. The second domain covered California and portions of Nevada at 12-km horizontal resolution to capture mesoscale (subregional) air flow features and their impacts on local meteorology. The third domain covered Central California at 4-km resolution to capture localized air flow features. The 4-km domain included the Bay Area, San Joaquin Valley, and Sacramento Valley, as well as portions of the Pacific Ocean and the Sierra Nevada range. The fourth domain covered the Bay Area and surrounding regions at 1-km resolution. All four domains employed 50 vertical layers, with the layer thickness increasing with height from the surface to the top of the modeling domain (about 18 km).

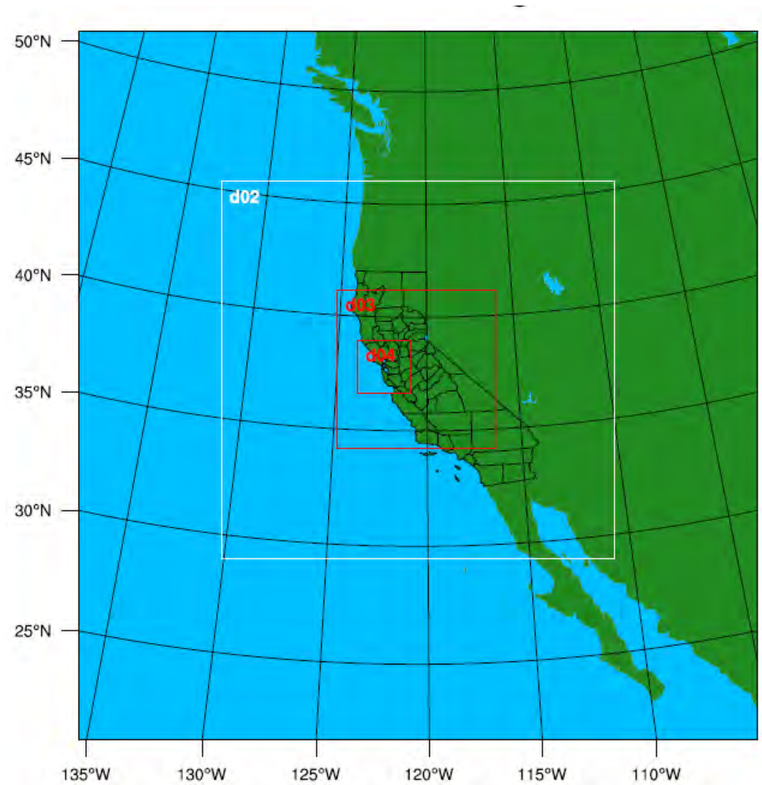


Figure 2.2.1: Nested WRF modeling domains.

The WRF model was tested using available options for physics and dynamics, as well as the datasets used to initialize and drive the model. Options tested included: (1) planetary boundary layer processes, (2) land surface processes, (3) four-dimensional data assimilation (FDDA) strategies, (4) horizontal and vertical diffusion algorithms, (5) advection schemes, and (6) initial and boundary conditions. Results of each test were evaluated, and the best-performing set of options was selected for final modeling.

WRF was applied for 2016, 2017, and 2018. Observed winds and temperatures were ingested into the model as the simulations were performed to increase the representation of local and regional meteorology. Table 2.2.1 provides a summary of annual mean model performance at five observation stations, from Vallejo in the north to San Jose in the south. The performance displayed is typical for the WRF model when it is applied over complex terrain. Variability in station performance is relatively small from year to year and fairly consistent among stations as well.

Example results from the rigorous model evaluation of WRF are provided in Appendix B. The first example shows simulated and observed time series plots of winds and temperatures at the PBF East meteorological monitoring tower and a comparison between them. The second example shows vertical profiles of simulated and observed temperature and humidity at the Oakland upper air meteorological station for summer and winter days of 2018. A brief discussion on the comparison between simulated and observed fields is also provided in Appendix B.

Table 2.2.1: A summary of the statistical evaluation of WRF for 2016–2018.

2016			**PBF East**	**San Jose**	**Oakland**	**San Pablo**	**Vallejo**
Wind Speed	Bias	(m/s)	0.00	−1.45	−1.63	−0.44	−0.26
Wind Speed	Gross Error	(m/s)	0.92	1.55	1.80	1.71	0.80
Wind Speed	RMSE	(m/s)	1.14	1.84	2.13	2.02	0.96
Wind Speed	IOA		0.67	0.61	0.59	0.59	0.68
Wind Direction	Bias	(deg)	8.18	16.78	2.37	−2.25	0.50
Wind Direction	Gross Error	(deg)	44.14	41.68	31.99	34.04	33.58
Temperature	Bias	(°K)	0.50	0.77	0.23	0.71	0.84
Temperature	Gross Error	(°K)	1.25	1.35	1.20	1.49	1.42
Temperature	RMSE	(°K)	1.51	1.61	1.46	1.79	1.70
Temperature	IOA		0.92	0.92	0.90	0.84	0.90
2017			**PBF East**	**San Jose**	**Oakland**	**San Pablo**	**Vallejo**
Wind Speed	Bias	(m/s)	0.15	−1.32	−1.47	−0.71	−0.09
Wind Speed	Gross Error	(m/s)	0.91	1.44	1.68	1.62	0.77
Wind Speed	RMSE	(m/s)	1.13	1.73	2.03	1.97	0.94
Wind Speed	IOA		0.67	0.64	0.60	0.58	0.68
Wind Direction	Bias	(deg)	6.77	20.42	−1.35	−1.41	−0.16
Wind Direction	Gross Error	(deg)	45.92	42.99	33.55	35.95	36.22
Temperature	Bias	(°K)	0.38	0.57	0.47	0.59	0.73
Temperature	Gross Error	(°K)	1.33	1.32	1.40	1.52	1.48
Temperature	RMSE	(°K)	1.59	1.58	1.67	1.81	1.76
Temperature	IOA		0.92	0.92	0.88	0.85	0.90
2018			**PBF East**	**San Jose**	**Oakland**	**San Pablo**	**Vallejo**
Wind Speed	Bias	(m/s)	0.03	−1.34	−1.50	−0.77	−0.24
Wind Speed	Gross Error	(m/s)	0.87	1.44	1.67	1.56	0.76
Wind Speed	RMSE	(m/s)	1.06	1.72	2.00	1.87	0.93
Wind Speed	IOA		0.66	0.63	0.59	0.58	0.69
Wind Direction	Bias	(deg)	10.67	11.95	0.35	−1.28	−2.80
Wind Direction	Gross Error	(deg)	47.11	39.04	33.34	36.22	34.03
Temperature	Bias	(°K)	0.54	0.60	1.09	0.72	0.70
Temperature	Gross Error	(°K)	1.44	1.29	1.45	1.64	1.47
Temperature	RMSE	(°K)	1.73	1.56	1.78	1.96	1.78
Temperature	IOA		0.92	0.93	0.88	0.84	0.91

2.3 Application of CALPUFF

Meteorological inputs to CALPUFF were prepared using outputs from the WRF model. The Mesoscale Model Interface (MMIF) computer program (Version 3.4.1; Brashers and Emery,

2019) was used for this purpose. This program extracts parameters from WRF outputs that are needed as CALPUFF inputs, such as wind speed, temperature, mixing height, surface roughness length, land use category, terrain elevation, and leaf area index.

MMIF provides two options for diagnosing the gridded Pasquill–Gifford (PG) stability classes required by CALPUFF. The first option is called the Solar Radiation/Delta-T (SRDT) method, which derives the PG stability class based on wind speed, solar radiation, and temperature (EPA, 1993). The second option derives the stability class from the parameterization of relationships between Monin–Obukhov lengths and surface roughness (Golder, 1972). The second option was selected for this project, and this choice is consistent with recent BAAQMD AERMOD applications in West Oakland.

CALPUFF uses far fewer vertical layers than WRF. MMIF performs a down-scaling of high resolution WRF layers to CALPUFF layers. CALPUFF layers used in this study were based on recommendations developed by modelers from the EPA and the Federal Land Manager (FLM) community (EPA, 2009). The layer definition is shown in Table 2.3.1.

Table 2.3.1: CALPUFF layers above ground level.

Layer	Layer Top Height (m)
1	20
2	40
3	80
4	160
5	320
6	640
7	1,200
8	2,000
9	3,000
10	4,000

CALPUFF provides many options for selecting model processes, such as wet scavenging, dry deposition, stack tip downwash, and building downwash. These options can be selected and assigned a value; if not selected, no value is assigned. The available options were carefully reviewed and selected for handling complex terrain with diverse meteorological conditions. The selected options and their values are shown in Appendix C.

CALPUFF simulations were performed for three years (2016–2018) and for two receptor grid configurations. The first simulation used 1-km computational and receptor domains over the entire Bay Area and included emissions from all point sources at the PBF facility. Annual average $PM_{2.5}$ concentrations were estimated for each year. The purpose of this simulation was to identify the areal extent of annual average concentrations exceeding 0.1 $\mu g/m^3$.

The second simulation used 1-km computational and 100-m receptor domains over the area for which annual average concentrations exceeded 0.1 $\mu g/m^3$ from the first simulation. A 5-km buffer zone was established between areas with concentrations exceeding 0.1 $\mu g/m^3$ and boundaries of the 100-m receptor domain to minimize boundary impacts on estimated concentrations. The second simulation also included emissions from all point sources at this facility. The purpose of the second simulation was to increase the density of receptors at locations where $PM_{2.5}$ concentrations were highest.

Additional simulations were conducted that used the same computational and receptor domains as the second simulation, but only included $PM_{2.5}$ emissions from the FCCU (with and without a WGS installed) at PBF.

Figure 2.3.1 shows the 1-km (gray box) and 100-m (red box) receptor domains used for all simulations. This figure also shows three-year (2016–2018) average $PM_{2.5}$ concentrations at 1-km receptor resolution that included emissions from all point sources at the PBF facility.

For all simulations, background (regional) concentrations and incoming pollutants through boundaries of the modeling domain were set to zero. In other words, estimated concentrations are entirely from facility emissions.

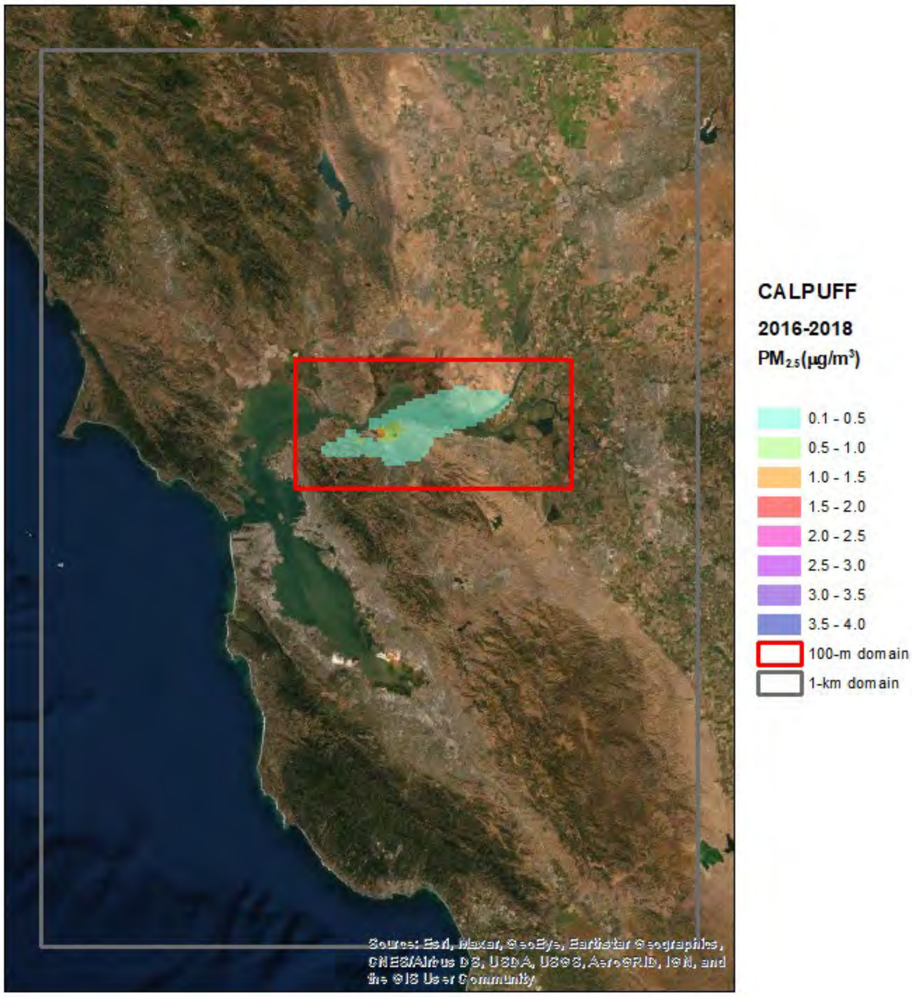


Figure 2.3.1: The gray and red boxes show the 1-km and 100-m receptor domains, respectively. CALPUFF-simulated three-year average $PM_{2.5}$ concentrations are also shown.

3 Results

3.1 Simulations with Emissions from All Sources

Figure 3.1.1 shows the three-year (2016–2018) average CALPUFF-simulated $PM_{2.5}$ concentrations for the 100-m receptor domain. Estimated concentrations within the PBF facility fence line are not shown. Estimated concentrations below 0.1 µg/m^3 are also excluded.

CALPUFF estimates concentrations at receptor points located at the center of each 100 x 100 m grid cell. For mapping purposes, each grid cell is color coded based on the concentration value at its center. An interval of 0.5 µg/m^3 was selected for color coding (except for concentrations between 0.1 µg/m^3 and 0.5 µg/m^3).

As can be seen in Figure 3.1.1a, the lowest concentration bin (0.1 µg/m^3 to 0.5 µg/m^3) extends from Pleasant Hill in the south to Birds Landing in the north and from Pinole Valley in the west to Decker Island in the east. The emissions plume has an elongated shape in the southwesterly and northeasterly directions from Martinez, consistent with the predominant winter and summer wind patterns there, respectively.

The area with concentrations above 0.5 µg/m^3 is much smaller than the area covered by the lowest concentration bin, as described above. These higher concentrations are mostly confined to the area around the PBF facility and extend toward the northeast of the facility.

To better visualize the high-concentration areas, a zoomed-in map of the 100-m receptor domain was created (see Figure 3.1.1b). As shown in this figure, an area with concentrations between 0.5 µg/m^3 and 1.0 µg/m^3 extends from the east side of the facility toward Port Chicago, between the southern bank of Suisun Bay and California Highway 4. There is also a small area with concentrations between 0.5 µg/m^3 and 1.0 µg/m^3 to the west of the facility.

Concentrations above 1.0 µg/m^3 primarily lie to the east of the facility, with no overlap of residential areas in the region. In addition, a sharp concentration gradient is apparent near the facility fence line. The maximum concentration (3.8 µg/m^3) is located just outside the fence line.

Additional analyses on the modeling results are presented in Appendix D.

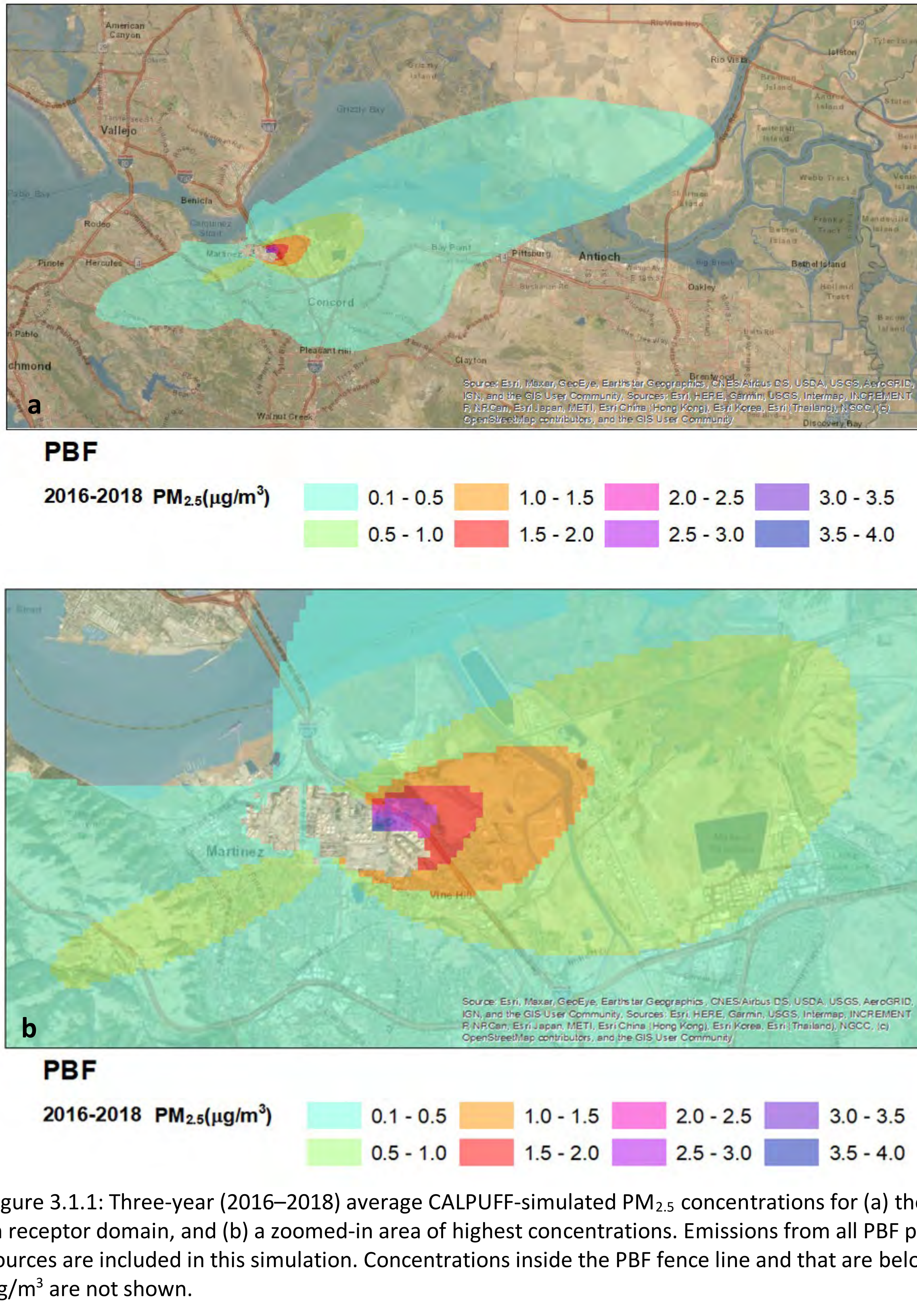


Figure 3.1.1: Three-year (2016–2018) average CALPUFF-simulated $PM_{2.5}$ concentrations for (a) the 100-m receptor domain, and (b) a zoomed-in area of highest concentrations. Emissions from all PBF point sources are included in this simulation. Concentrations inside the PBF fence line and that are below 0.1 $\mu g/m^3$ are not shown.

3.2 Simulations with FCCU Emissions

CALPUFF was also run with emissions from the FCCU only under two scenarios: (1) baseline FCCU emissions with existing stack parameters and (2) with emissions consistent and stack parameters consistent with a WGS installed.[2] (See Section 2.1 for a discussion of WGS emissions.)The resulting three-year average $PM_{2.5}$ concentrations are shown in Figure 3.2.1 (baseline FCCU) and Figure 3.2.2 (FCCU with a WGS installed). Again, concentrations within the facility fence line and below 0.1 µg/m^3 are not shown. An interval of 0.2 µg/m^3 was selected for color coding concentration values at grid cells.

Emissions from this source are mainly transported to the southwest and northeast of the facility, similar to the all-source results, but with smaller impact areas. The number of receptors with three-year average concentrations above 0.1 µg/m^3 was reduced from 42,741 (all-source simulation) to 21,452 (FCCU-only simulation), i.e., a 50% reduction when a WGS is not installed. The maximum three-year average concentration from this source is 2.0 µg/m^3, or about 53% of the maximum concentration from the all-source simulation. This is slightly less than the contribution of the FCCU to total $PM_{2.5}$ emissions from the facility (65%).

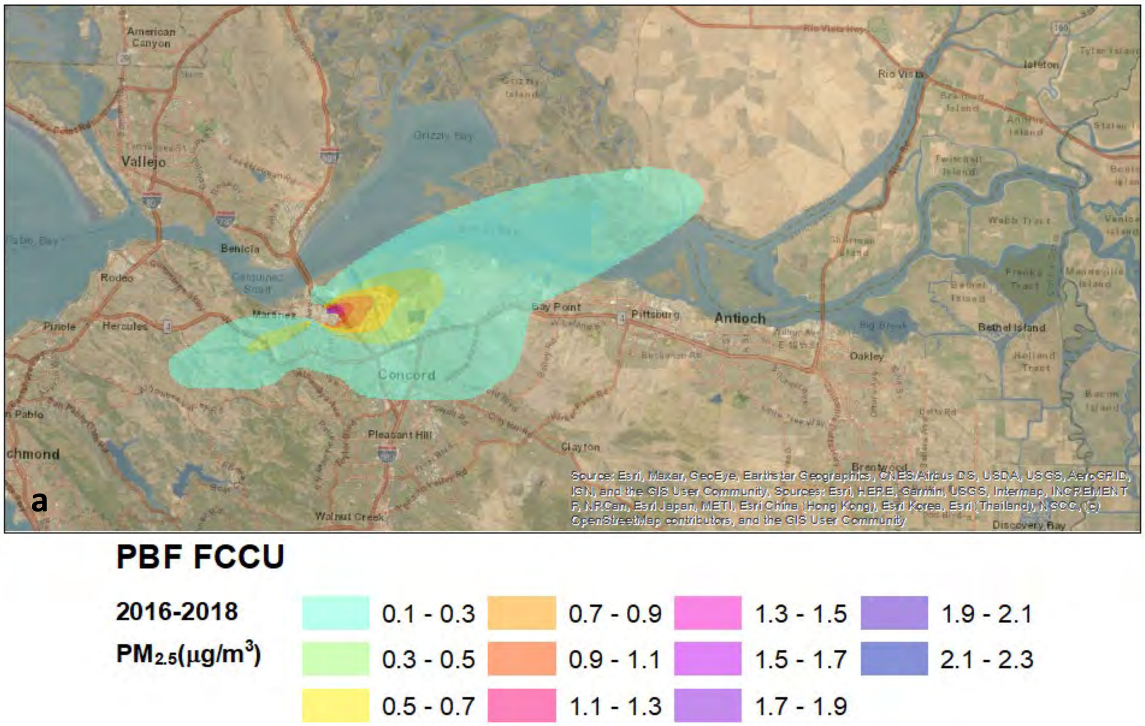
Installation of a WGS further reduces the number of receptors with three-year average concentrations above 0.1 µg/m^3 to 1,078 (a 95% reduction from the baseline FCCU emission scenario) and the maximum three-year average concentration to 0.46 µg/m^3 (22% of the maximum concentration from the baseline FCCU emission scenario). This reduction in the maximum concentration is consistent with the emission reduction by a WGS (78%) as the maximum concentration occurs close to the source location.

Table 3.2.1 shows the key findings of simulations with the three sets of emissions.

Table 3.2.1: Key findings of simulations with emissions from all point sources, FCCU only, and FCCU with assumed WGS.

	Annual $PM_{2.5}$ emissions (tons/year)	**Maximum simulated concentrations (µg/m^3)**	**Number of sampling receptors with concentrations above 0.1 µg/m^3**
All point sources	463.20	3.8	42,741
FCCU only, baseline	299.61	2.0	21,452
FCCU with assumed WGS	65.91	0.46	1,078

[2] Note that a scenario for a less stringent emissions limit (0.02 grains per dry standard cubic foot) was developed by scaling concentrations from the baseline FCCU scenario.



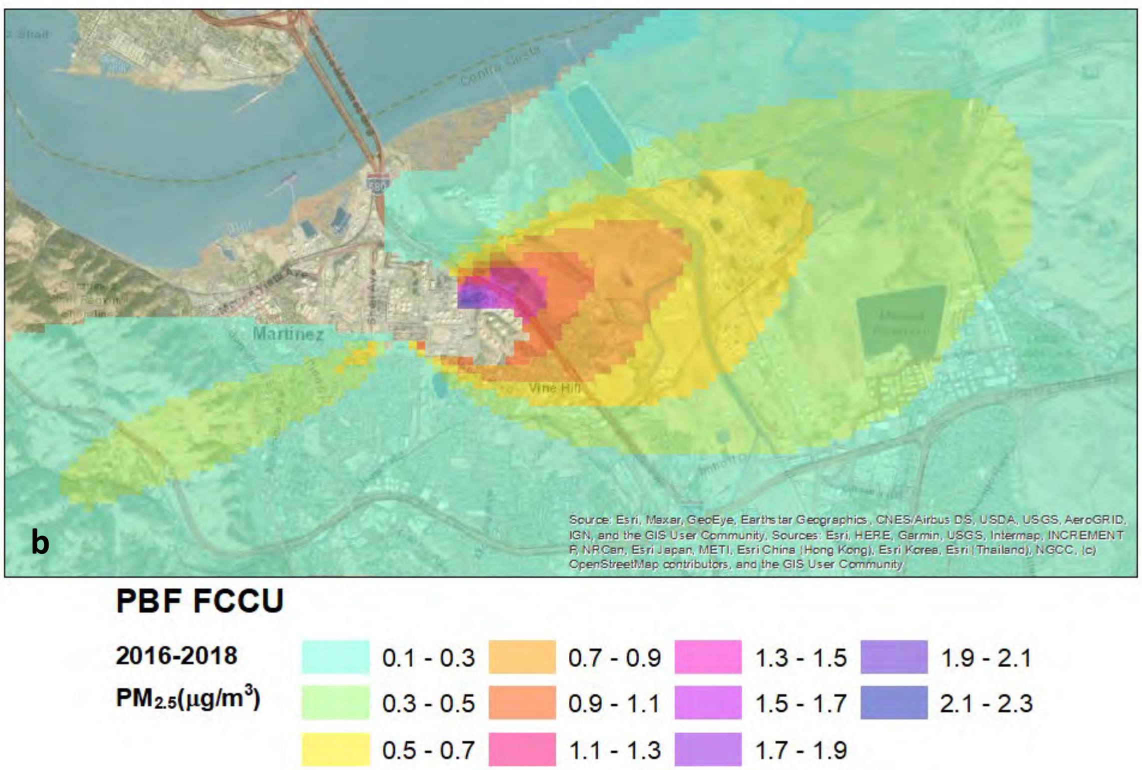


Figure 3.2.1: Three-year (2016–2018) average CALPUFF-simulated $PM_{2.5}$ concentrations for: (a) the 100-m receptor domain, and (b) a zoomed-in area of high concentrations. Emissions from the FCCU only (without a WGS) are included in these simulations. Concentrations inside the PBF fence line and that are below 0.1 µg/m^3 are not shown.

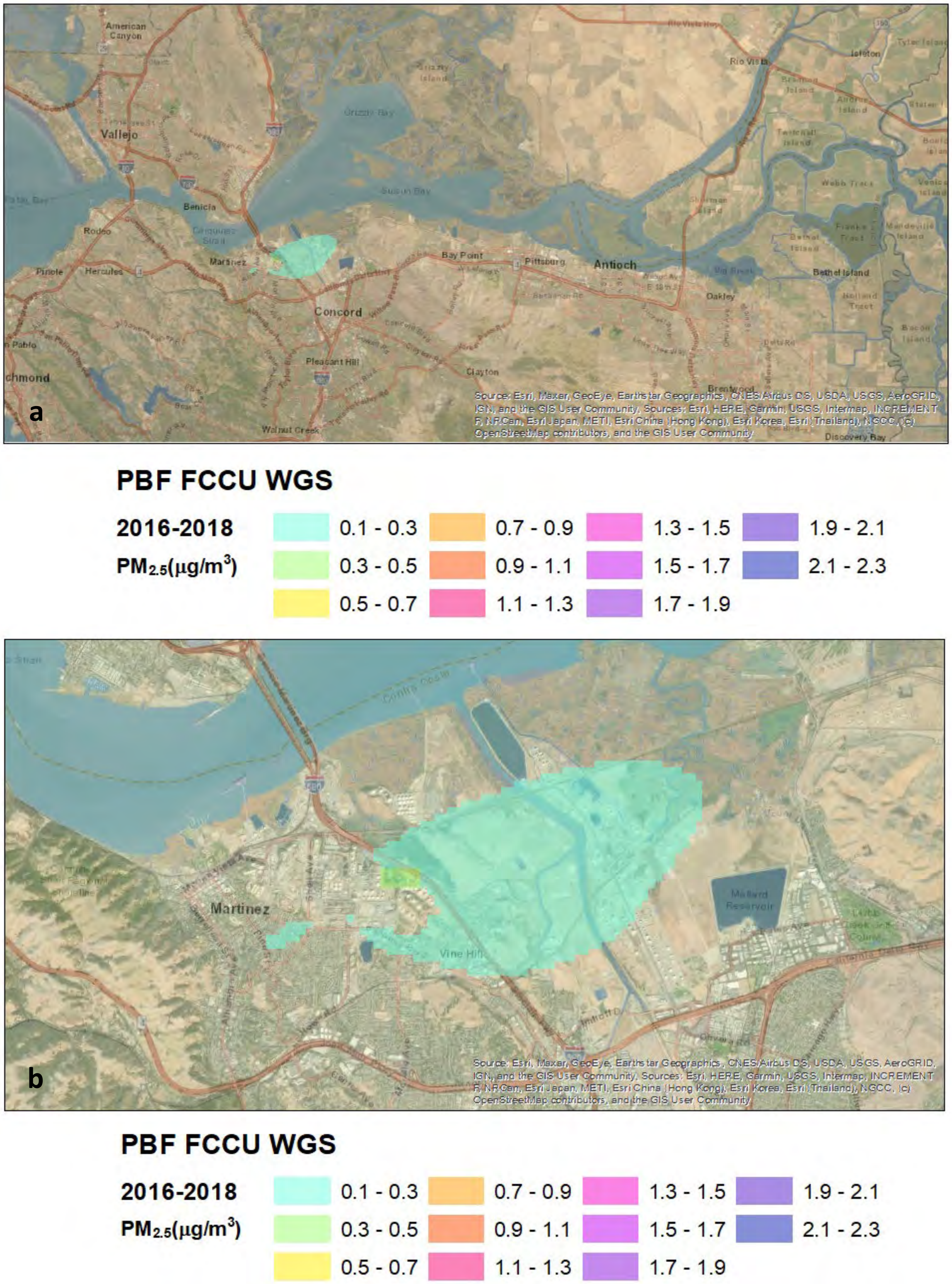


Figure 3.2.2: Three-year (2016–2018) average CALPUFF-simulated $PM_{2.5}$ concentrations for: (a) the 100-m receptor domain, and (b) a zoomed-in area of high concentrations. Emissions from the FCCU only (with an assumed WGS) are included in these simulations. Concentrations inside the PBF fence line and that are below 0.1 μg/m^3 are not shown.

4 Summary

The purpose of this project is to estimate contributions of directly emitted fine particulate matter from major industrial facilities in the Bay Area to ambient $PM_{2.5}$ concentrations. Project findings are expected to support the District's AB 617 program, providing technical information to decision makers, planners, the AB 617 technical assessment team, and rule developers.

We have previously estimated contributions of $PM_{2.5}$ emissions from the Chevron refinery, and in this study, we estimated contributions of emissions from the PBF refinery to ambient $PM_{2.5}$ levels for 2016–2018. Modeling analyses of the impacts of emissions from other Bay Area refineries and the Lehigh Cement factory will follow using an approach similar to the one used for the Chevron and PBF refineries.

The technical approach developed for this project was carefully evaluated. Options were weighed and discussed among the modeling team, and the strategy that was anticipated to provide the best modeling results was adopted. In addition, consideration was given to providing results that would address the needs of anticipated end users.

The opening sections of this document provide detailed information on the purpose of the project, model selection, and types of analyses conducted. This document also provides a summary of emissions and meteorological input preparation, model execution, analysis and interpretation of model outputs, and QA/QC performed.

Key findings of the project include:

- Simulating three years provides better representation of average concentrations.
- CALPUFF results show some differences among the years simulated, but overall characteristics of simulated $PM_{2.5}$ concentrations are consistent among the years.
- The single FCCU that accounts for about 65% of total $PM_{2.5}$ emissions from PBF contributes about 53% of the peak three-year average contributions from all PBF sources.
- Installation of a WGS, which reduces the FCCU emissions by 78%, reduces the peak three-year average contribution from the FCCU by the same percentage.
- The peak annual average $PM_{2.5}$ concentration is just outside the facility's northeastern fence line, but concentrations quickly diminish at a short distance away from the facility.
- Peak monthly average $PM_{2.5}$ concentrations are higher in summer than in winter due to stronger vertical mixing during the summer months.

5 References

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Appendix A – Emissions Inventory Preparation

As described in the body of this report, QC checks were performed on stack parameters for PBF $PM_{2.5}$ sources prior to modeling. For example, a range check was performed on each stack parameter to ensure that all values fell within reasonable bounds. In a few cases, stack parameters were flagged and updated in consultation with staff from the Engineering Division. Table A.1 shows the results of range checks for the final set of stack parameters used in the CALPUFF modeling.

In addition, the base elevation and stack height for each modeled source were added to calculate an actual release point. These values were then compared with the vertical layer structure of the CALPUFF model to determine how emissions would be apportioned vertically. This comparison does not include plume rise.

About 352 tons of $PM_{2.5}$ (76% of the total) were being injected into CALPUFF layer 3, which begins at a height of 60 m and is 40 m thick (see Table A.2).

Table A.1: Results of range check for stack parameters assigned to PBF sources.

Parameter	Base Elevation (m)	Stack Height (m)	Stack Diameter (m)	Exit Temperature (°K)	Exit Velocity (m/s)	$PM_{2.5}$ Emissions (tons/year)
Minimum	10.25	2.44	0.15	293	1.80	0.0036
Maximum	20.53	107.00	5.76	1273	68.75	104.25

Table A.2: Results of mapping sources and emissions to CALPUFF layers.

CALPUFF Layer	Layer Height (m)	Layer Thickness (m)	Number of Sources	$PM_{2.5}$ Emissions (tons/year)
1	20	20	2	0.36
2	40	20	16	20.99
3	80	40	12	352.03
4	160	80	7	89.81
5	320	160		
6	640	320		
7	1,200	560		
8	2,000	800		
9	3,000	1,000		
10	4,000	1,000		

Appendix B – Meteorological Model Evaluation

The WRF model was applied for three years (2016–2018) and evaluated against available surface and upper air observations, especially for its 1-km modeling domain. Ramboll's METSTAT program[3] was used for evaluating the model against surface observations. This program compares hourly average WRF-simulated meteorological fields against observations, calculates statistical measures such as mean observation, mean simulation, bias, error, gross error, root-mean-square error (RMSE), and index of agreement, and then tabulates and graphically displays findings.

For evaluating the model against upper air measurements, a skew-T plot program was used. This program plots simulated and observed temperatures and humidity in the vertical direction.

A summary table of estimated statistical measures is provided in the main body of this document. Time series comparisons between simulated and observed wind speeds, wind directions, and temperatures are presented in Section B.1. Sample skew-T plots are presented in section B.2.

B.1 Time Series Comparisons

We compared simulated winds and temperatures against observations to evaluate the model. Even though the model was evaluated against available observations archived at the National Center for Atmospheric Research and in the District's Data Management System, only time series plots at the PBF facility are shown in this Appendix. To better show comparison details, time series plots are displayed for discrete calendar quarters.

Figures B.1 through B.9 show time series plots of daily average observed and WRF-simulated wind speeds, wind directions, and temperatures for 2016, 2017, and 2018, respectively. As these figures show, the WRF-simulated winds and temperatures match the observed trends exceptionally well for the whole simulation period. This good performance is due to the Modeling and Analysis Section's continuous evaluation of the WRF and efforts to improve model performance. Ingesting data from the relatively dense Bay Area observation network into the WRF also helps improve its performance. The WRF performance at PBF East is much better than that at Chevron—especially the temperature performance, which is consistently good for all three years. The systematic underestimation of wind speed at Chevron during the summer months is not noticeable at PBF. The PBF facility is located sufficiently inland away from the Pacific Ocean to be less subject to the strong land–sea circulation.

Note that the y-axis showing wind direction spans from 0 to 360 degrees in Figures B.2, B.5, and B.8. Comparing wind directions slightly above 0 degrees and below 360 degrees can be falsely interpreted as significant mismatches between observations and simulations. In fact, 0 and 360 degrees overlap and directions slightly above 0 degrees and below 360 degrees should be

[3] http://www.camx.com/download/support-software.aspx

interpreted as being in reasonably good agreement.

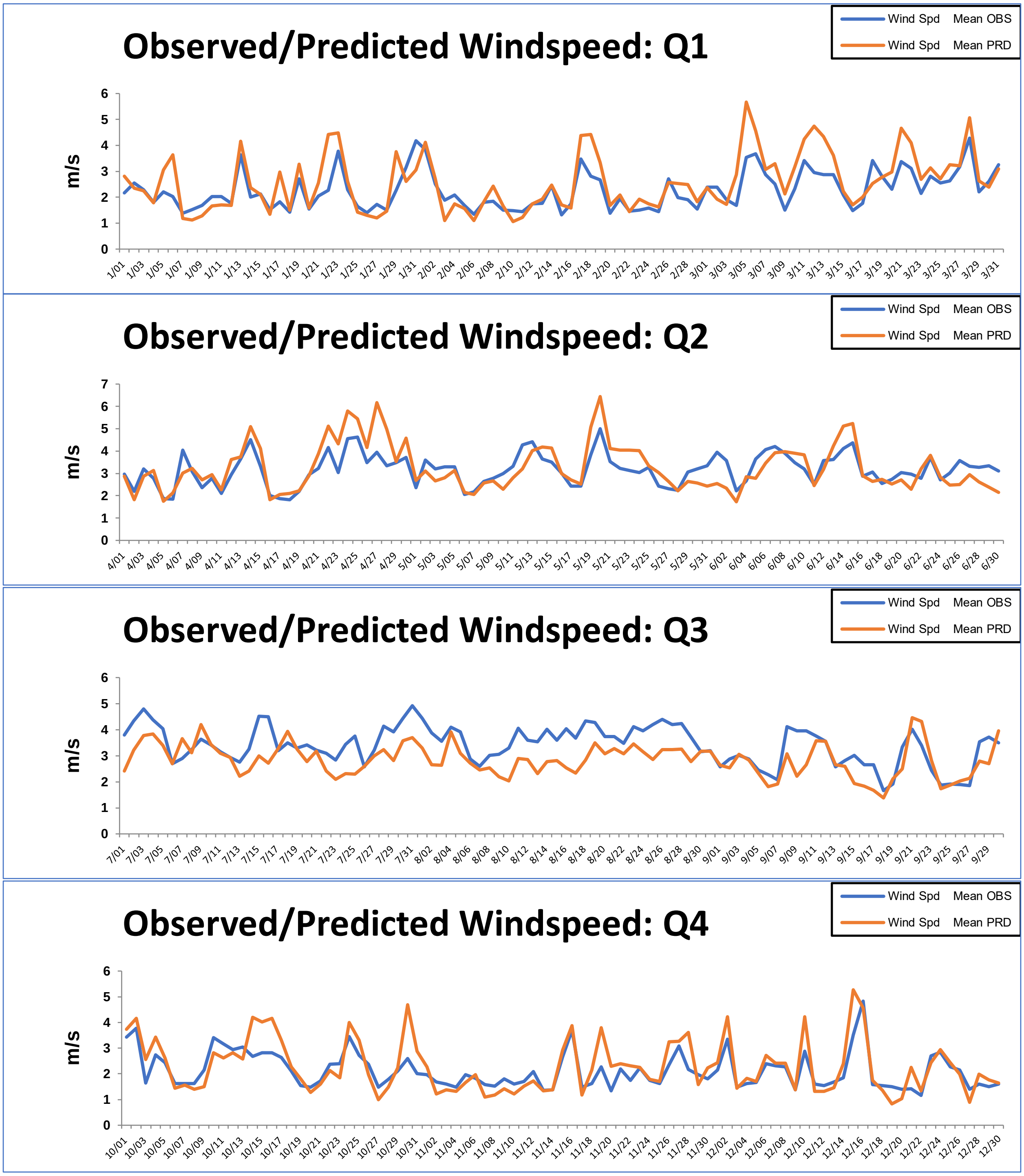

Figure B.1: Daily time series of observed and simulated wind speeds at the PBF East meteorological tower in Martinez for each quarter of 2016. “Mean OBS” is for all observations averaged over the 1-km domain. “Mean PRD” is for all prediction fields at the observation sites averaged over the 1-km domain.

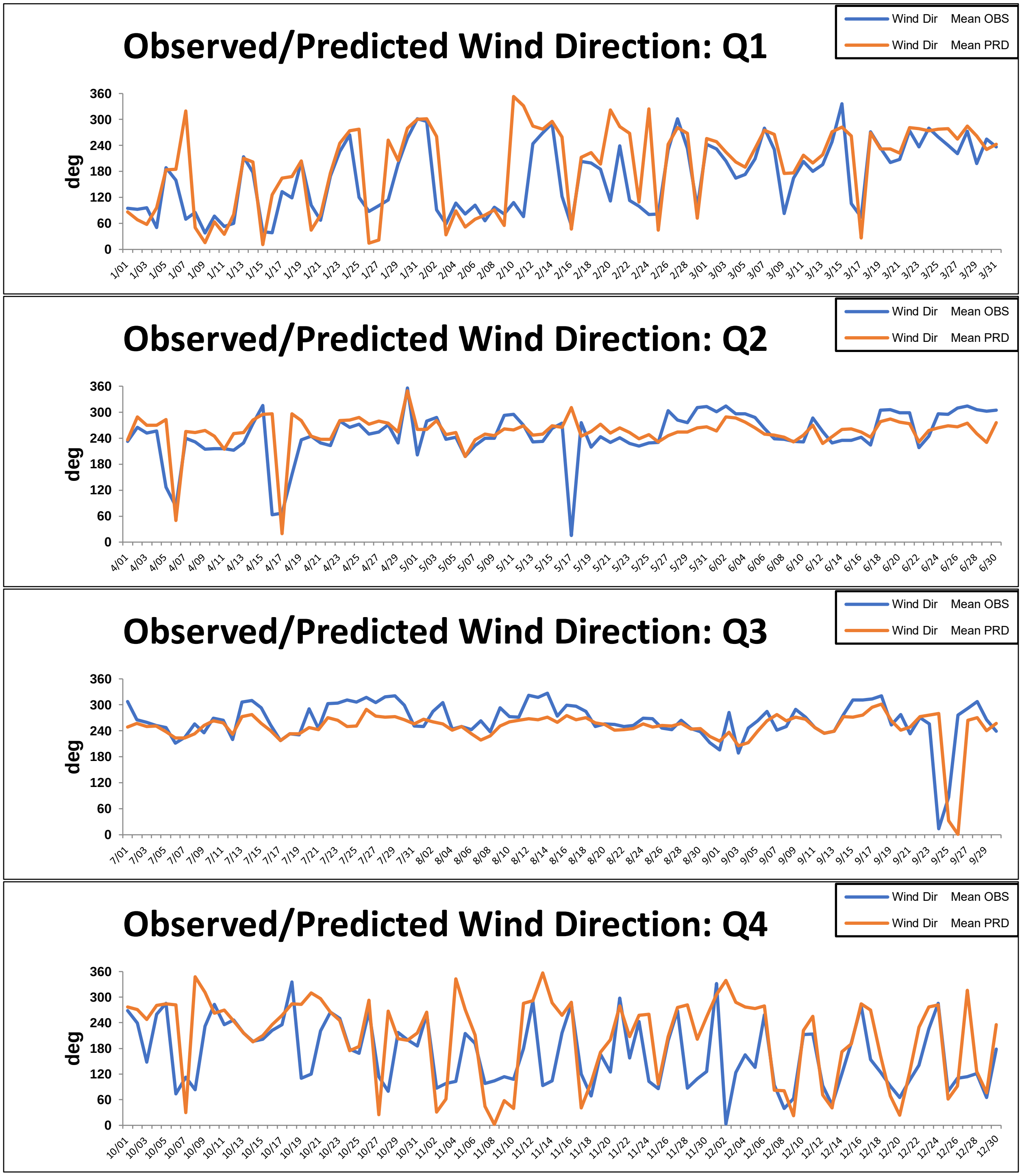

Figure B.2: Daily time series of observed and simulated wind directions at the PBF East meteorological tower in Martinez for each quarter of 2016. Note that 0 and 360 degrees overlap.

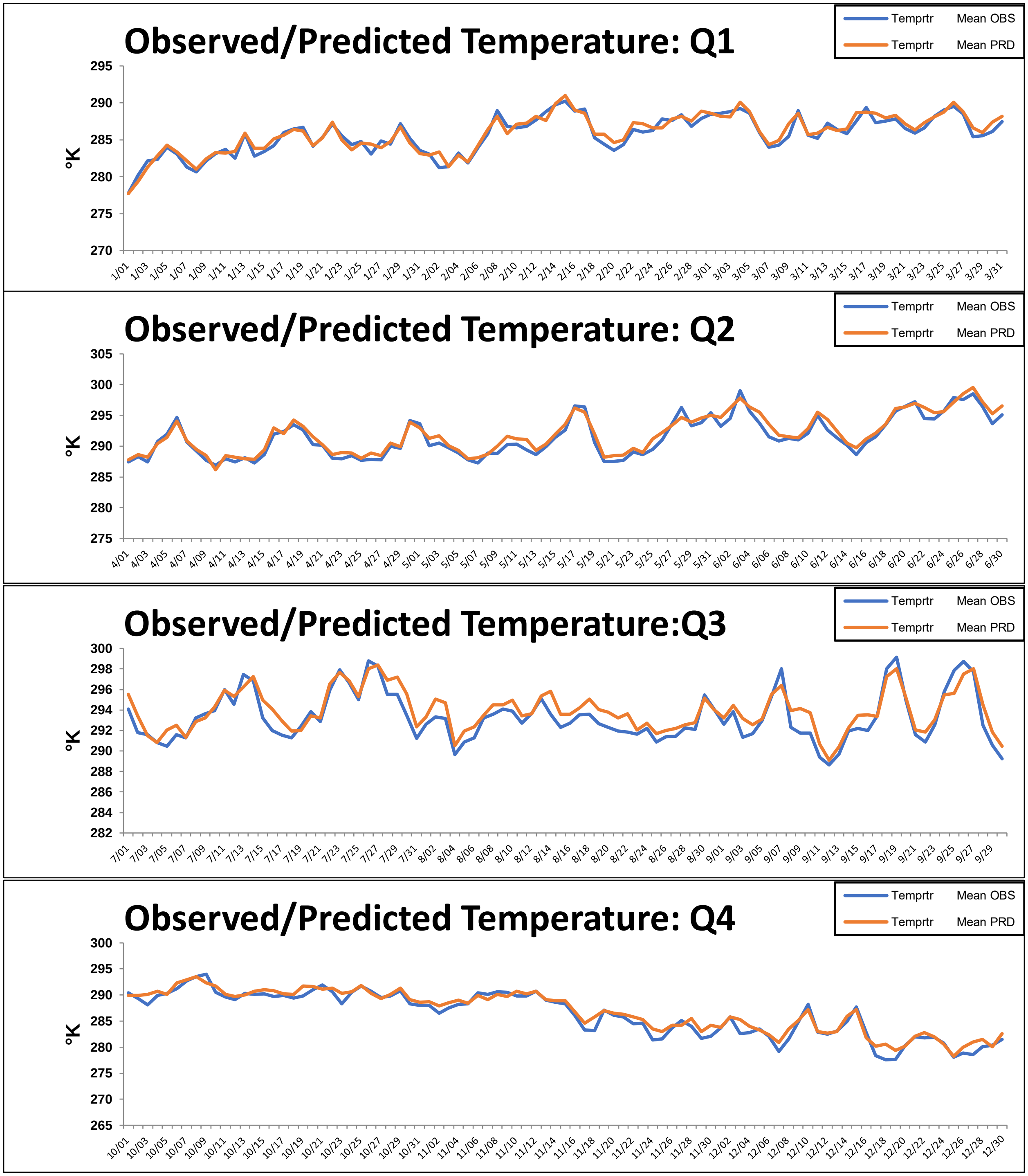

Figure B.3: Daily time series of observed and simulated temperatures at the PBF East meteorological tower in Martinez for each quarter of 2016.

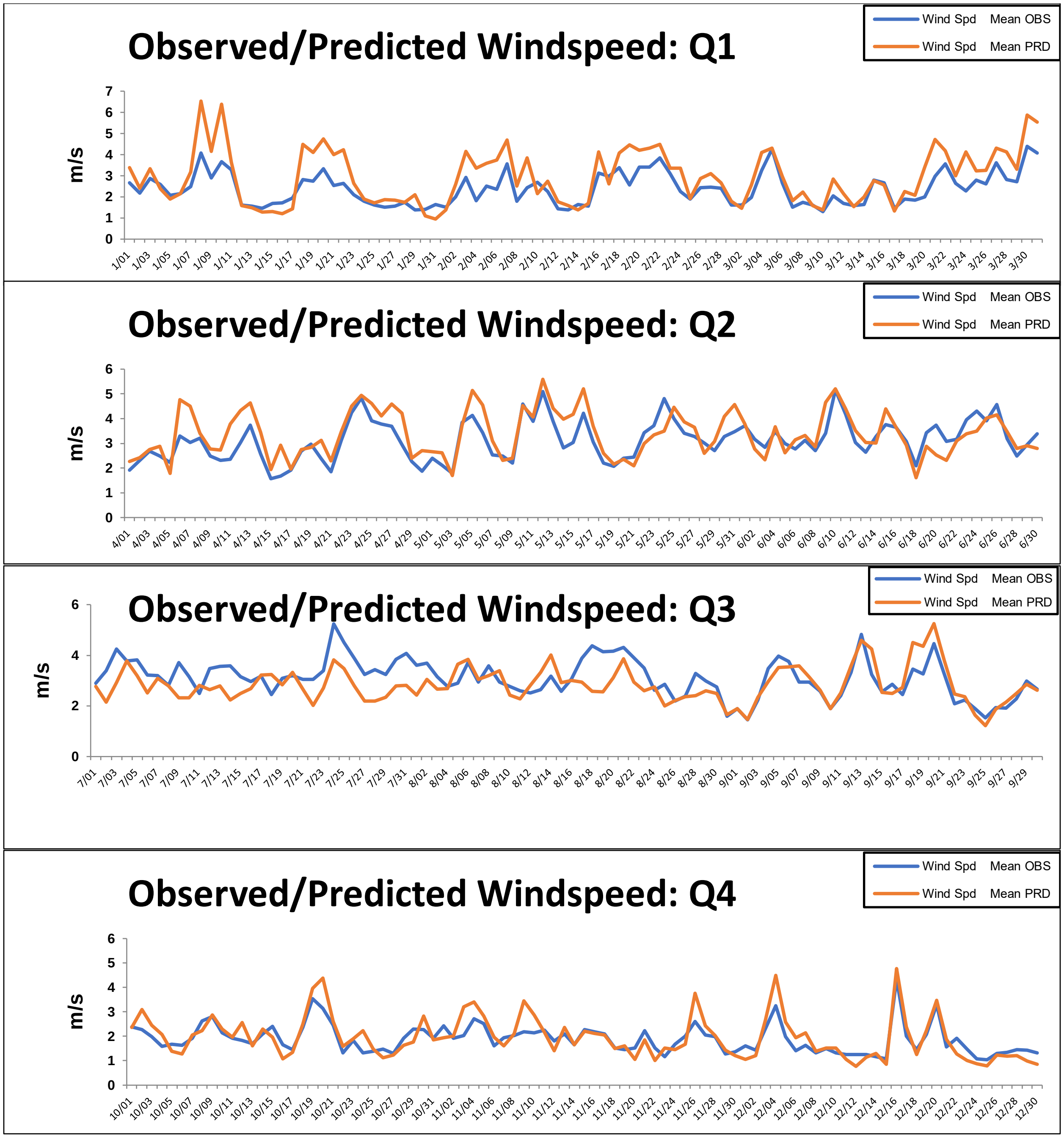

Figure B.4: Daily time series of observed and simulated wind speeds at the PBF East meteorological tower in Martinez for each quarter of 2017. “Mean OBS” is for all observations averaged over the 1-km domain. “Mean PRD” is for all prediction fields at the observation sites averaged over the 1-km domain.

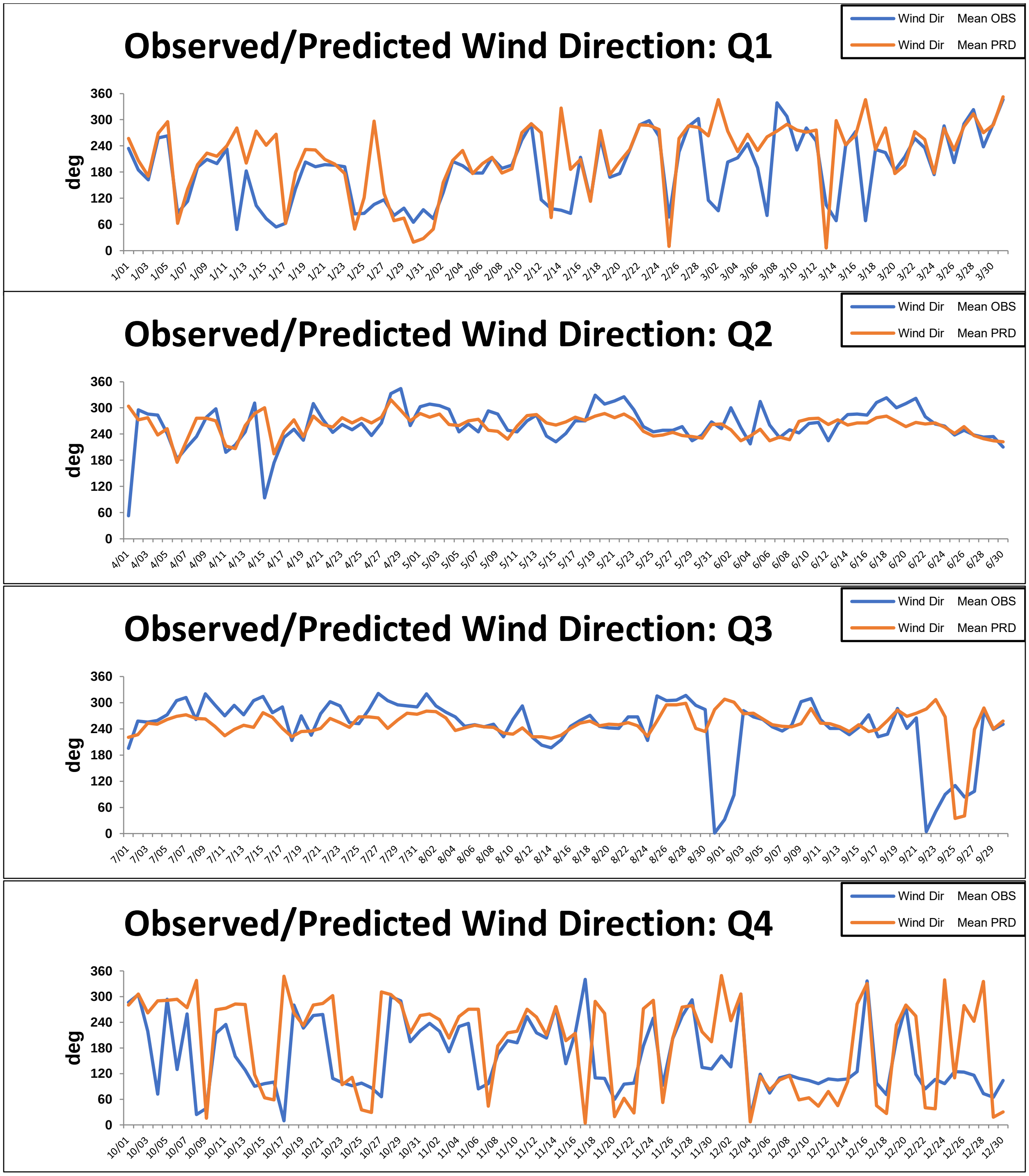

Figure B.5: Daily time series of observed and simulated wind directions at the PBF East meteorological tower in Martinez for each quarter of 2017. Note that 0 and 360 degrees overlap.

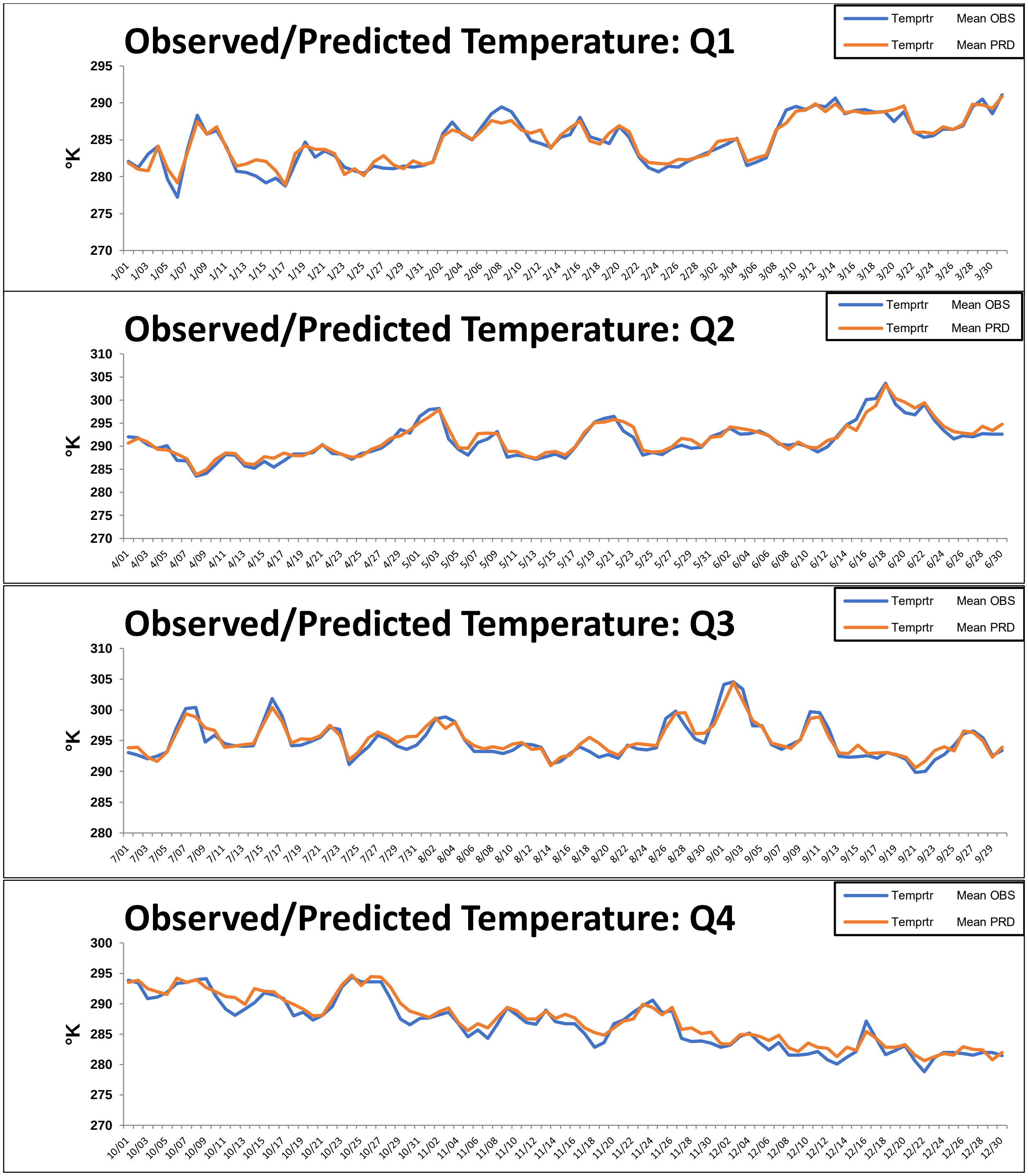

Figure B.6: Daily time series of observed and simulated temperatures at the PBF East meteorological tower in Martinez for each quarter of 2017.

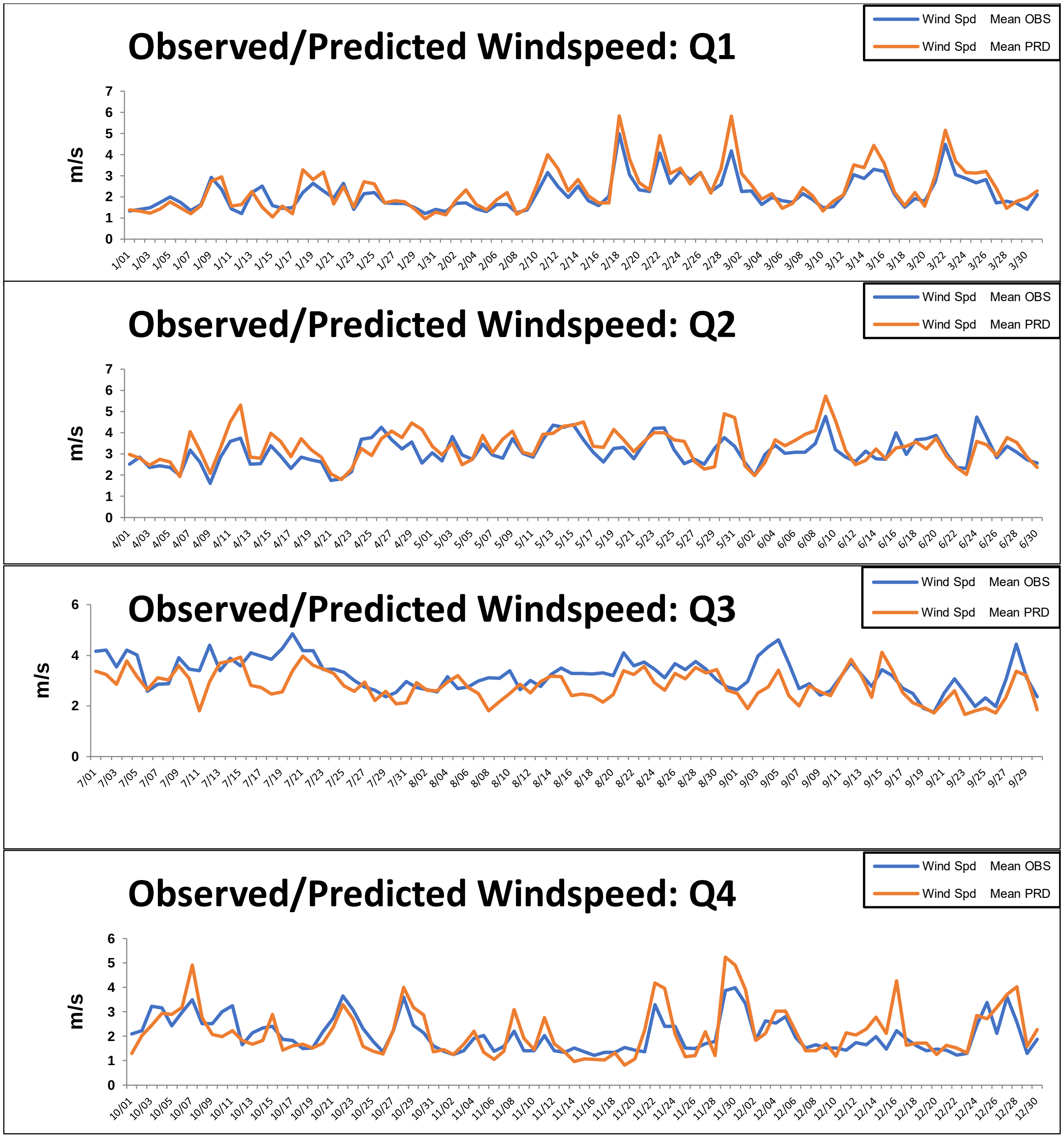

Figure B.7: Daily time series of observed and simulated wind speeds at the PBF East meteorological tower in Martinez for each quarter of 2018. “Mean OBS” is for all observations averaged over the 1-km domain. “Mean PRD” is for all prediction fields at the observation sites averaged over the 1-km domain.

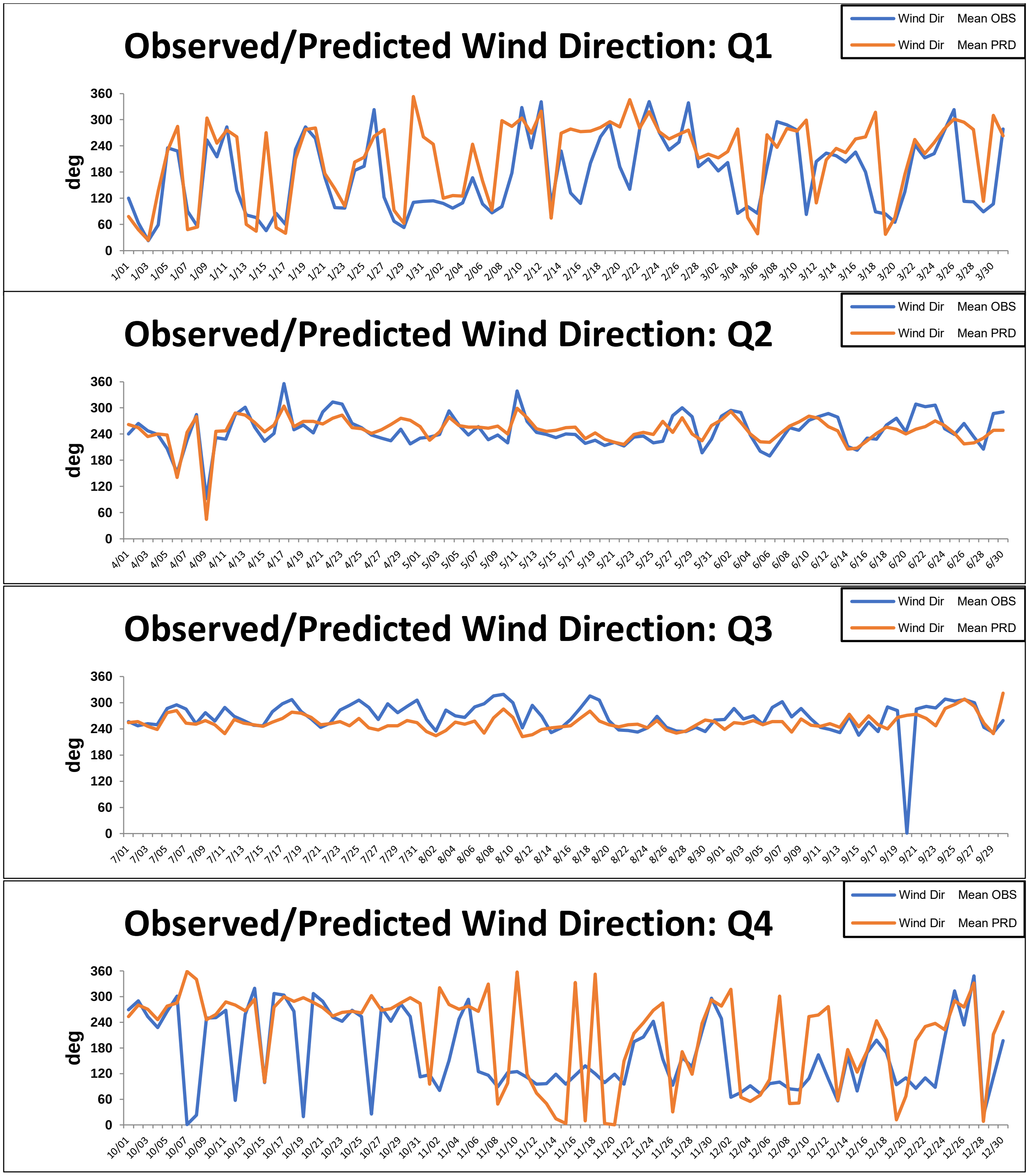

Figure B.8: Daily time series of observed and simulated wind directions at the PBF East meteorological tower in Martinez for each quarter of 2018. Note that 0 and 360 degrees overlap.

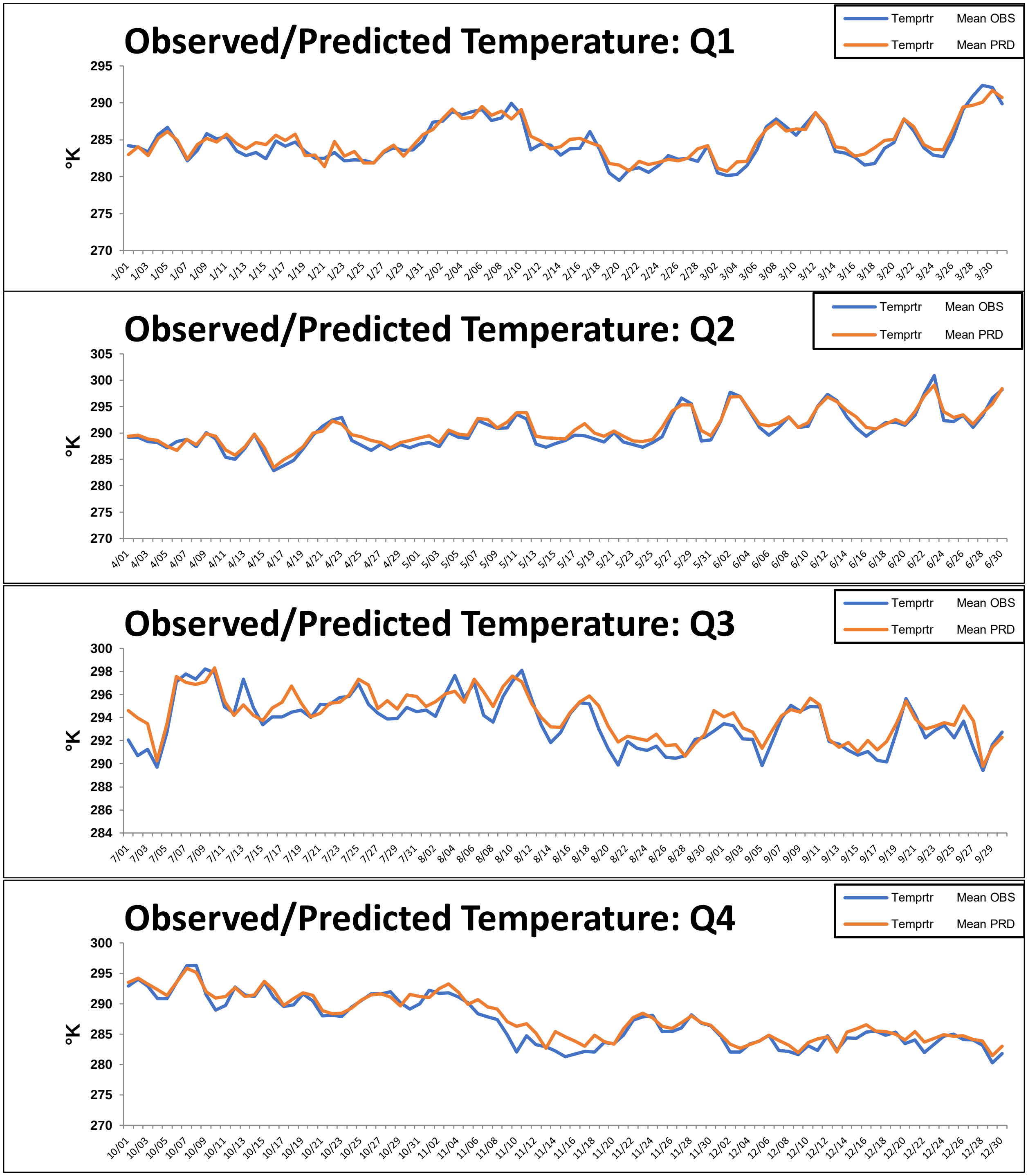

Figure B.9: Daily time series of observed and simulated temperatures at the PBF East meteorological tower in Martinez for each quarter of 2018.

B.2 Evaluating the WRF Model Against Upper Air Measurements

One upper air meteorological measurement station, located at Oakland International Airport and operated by the National Weather Service, is within the 1-km WRF modeling domain. Two daily measurements are conducted at 00 GMT and 12 GMT (4:00 pm and 4:00 am PST, respectively).

Outputs for the 1-km WRF model domain were compared against measurements at this site. For each day, simulations matched observations exceptionally well. Figures B.10 and B.11 show comparisons between simulations and observations for a winter and summer day for 2018. These days are randomly selected for the purpose of demonstration. They do not necessarily show the best or worst match between the simulations and observations.

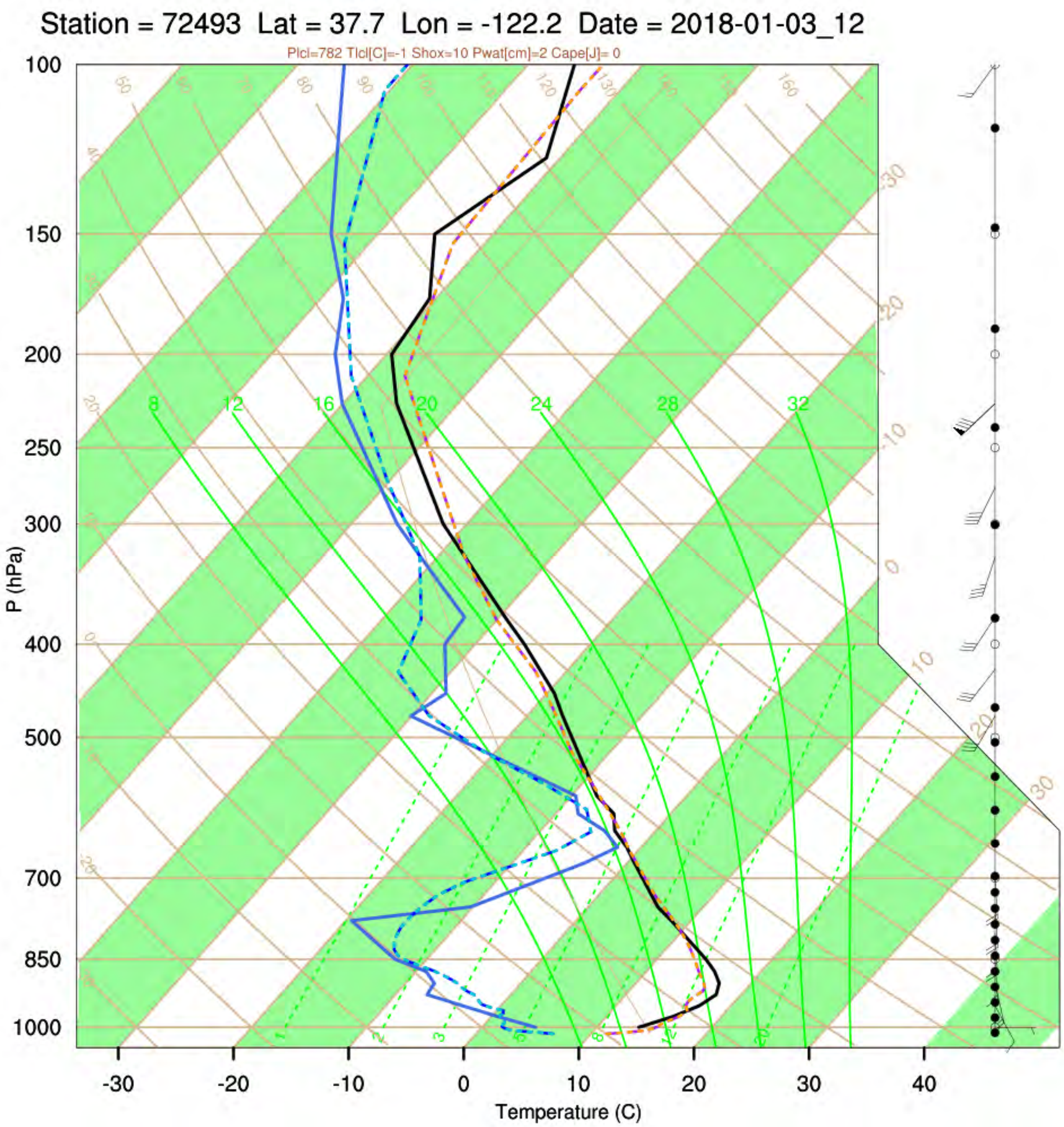

Figure B.10: A skew-T plot showing simulated (dashed lines) and observed (solid lines) temperatures (orange and black) and humidity (blue) at Oakland on January 3, 2018, at 12 GMT. Observed wind barbs at pressure levels are shown on the right y-axis.

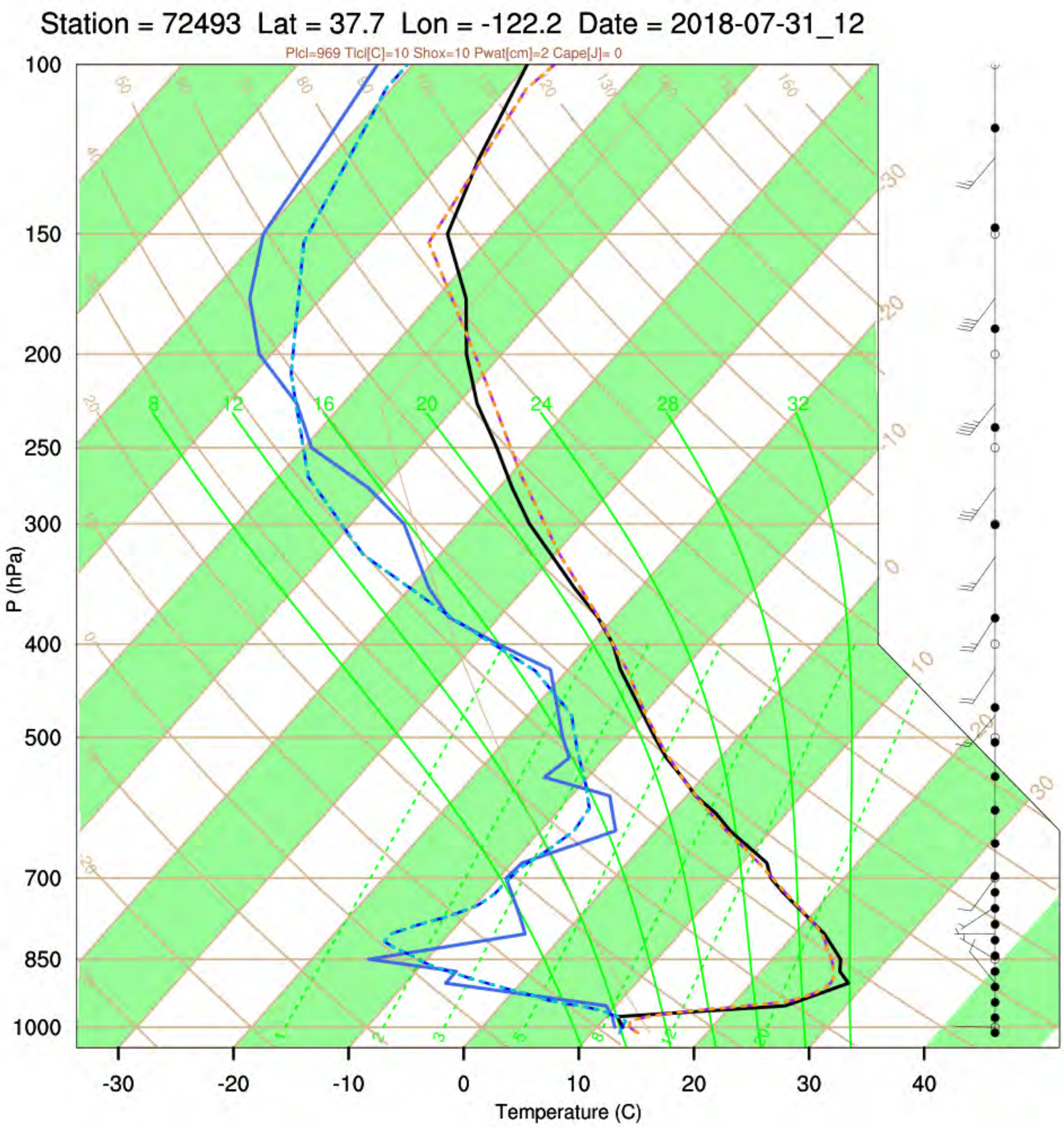

Figure B.11: A skew-T plot showing simulated (dashed lines) and observed (solid lines) temperatures (orange and black) and humidity (blue) at Oakland on July 31, 2018, at 12 GMT. Observed wind barbs at pressure levels are shown on the right y-axis.

Appendix C – CALPUFF Modeling Options

Primary $PM_{2.5}$ emitted from the PBF facility was modeled as an inert $PM_{2.5}$ species, i.e., secondary $PM_{2.5}$ formation in the atmosphere was not considered for this project. Pollutant removal processes due to wet scavenging and dry deposition were included. Parameters for wet scavenging and dry deposition are shown in Table C.1. Other CALPUFF modeling options used in this study are listed in Table C.2.

Table C.1: Parameters for wet scavenging and dry deposition.

Parameter		Value
Scavenging coefficient	Liquid precipitation	0.0001 s^{-1}
	Frozen precipitation	0.00003 s^{-1}
Particle size distribution	Geometric mean diameter	0.48 µm
	Geometric standard deviation	2.0 µm
Reference cuticle resistance		30 s/cm
Reference ground resistance		10 s/cm
Reference pollutant reactivity		8
# of particle-size intervals used to evaluate effective particle deposition velocity		9
Vegetation state in unirrigated areas		Active and unstressed vegetation

Table C.2: CALPUFF modeling technical options used in this study.

Option	Selected
Vertical distribution used in the near field	Gaussian
Terrain adjustment	Partial plume path adjustment
Subgrid-scale complex terrain	Not modeled
Near-field puffs modeled as elongated slugs	No
Transitional plume rise	Transitional rise computed
Stack tip downwash	Yes
Building downwash	No
Method used to compute plume rise for point sources not subject to building downwash	Briggs plume rise
Vertical wind shear modeled above stack top	No
Puff splitting	No
Gravitational settling (plume tilt)	No
Method used to compute dispersion coefficients	PG dispersion coefficients for rural areas; MP coefficients in urban areas
PG sigma (y, z) adjusted for roughness	No
Partial plume penetration of elevated inversion modeled for point sources	Yes
Strength of temperature inversion	Computed from measured/default gradients

Option	Selected
PDF used for dispersion under convective conditions	No
Subgrid TIBL module used for shoreline	No
Boundary conditions	No
Land use categories for which urban dispersion is assumed	13

Appendix D – CALPUFF Results

The purpose of this appendix is to provide additional information on CALPUFF results and to present findings from selected model performance evaluations. Since observations at air monitoring stations include $PM_{2.5}$ contributions from all sources (not just PBF), it is impossible to evaluate the model results against them. Therefore, we attempted to evaluate the model qualitatively, which includes examining the model's ability to capture monthly, seasonal, and year-to-year variability in concentration levels in response to changes in meteorological conditions.

Figure D.1 shows the annual average CALPUFF-simulated $PM_{2.5}$ concentrations for 2016, 2017, and 2018 across the 100-m receptor domain. There are some variations in concentrations among these years, which are thought to be due to year-to-year variability in meteorological conditions.

First, the areal extent of concentrations between 0.1 µg/m^3 and 0.5 µg/m^3 is different among these years. In 2016 and 2018, concentrations in this bin reached further to the east (covering Decker Island and Brannan Island State Recreation Area) compared with 2017, possibly due to stronger or more persistent westerly winds during those years.

In addition, monthly average $PM_{2.5}$ concentrations were calculated for each year, and the top five values within each month were then averaged to provide a representation of peak concentration levels. Differences in these top five monthly average concentrations were also evident among the three years, as shown in Figure D.2.

The model was able to capture differences among the same months across the years, as well as monthly variations within the same year. Differences among the same months across the years are significantly smaller than monthly variations within the same year. This is because vertical mixing is stronger during summer months, allowing more pollutants to reach ground level than in non-summer months.

Next, the number of receptors with annual average concentrations above 0.1 µg/m^3 was compared among the years, as shown in Table D.1. The number of receptors did not change significantly from year to year, indicating that while the shape of the emissions plume is different for each year due to year-specific meteorological conditions, the overall size of the area impacted does not change significantly.

Figure D.3 shows close-up maps of the 100-m receptor domain for 2016, 2017, and 2018. Areas covered by concentrations between 0.5 µg/m^3 and 1.0 µg/m^3 extend further in the northeast direction in 2016 and 2018 than in 2017. Conversely, the areas extend further in the southeast direction in 2017 than in 2016 and 2018. These close-up maps also show that year-to-year variability in concentrations is captured by the model.

For reference, we also plotted simulated annual average concentrations for 2016, 2017, and

2018 baseline emissions from only the FCCU for the 100-m receptor domain (Figure D.4) and for a close-up area of the 100-m domain (Figure D.5). Both sets of figures look reasonable.

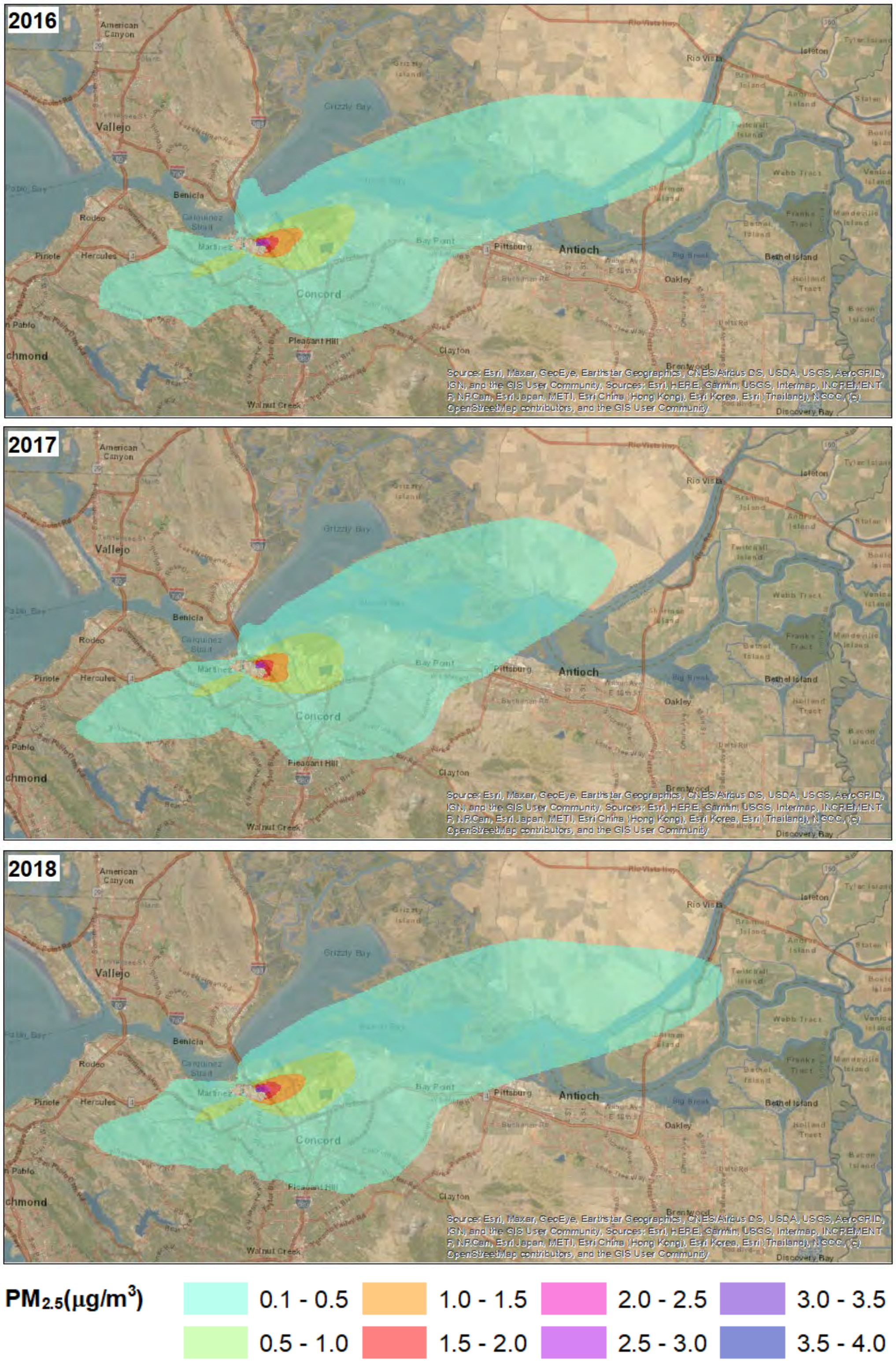

Figure D.1: Annual average CALPUFF-simulated $PM_{2.5}$ concentrations for the 100-m receptor domain for 2016, 2017, and 2018. $PM_{2.5}$ emissions from all PBF point sources were included in these simulations.

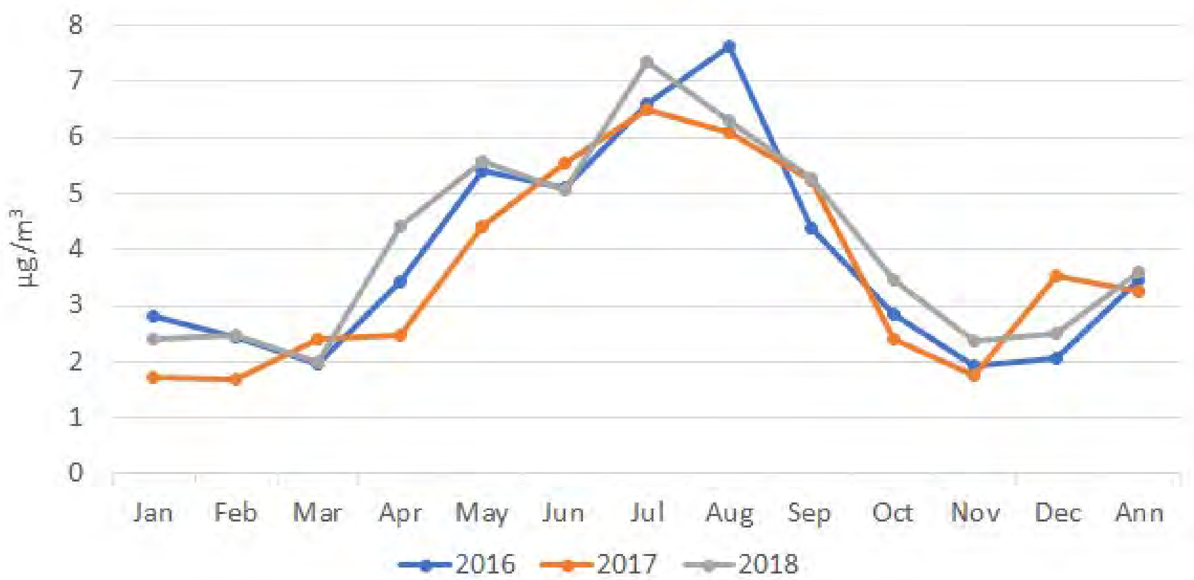

Figure D.2: Average of top five monthly average $PM_{2.5}$ concentrations for 2016, 2017, and 2018.

Table D.1: Number of 100-m receptors with CALPUFF-simulated annual average $PM_{2.5}$ concentrations above 0.1 µg/m^3.

2016	2017	2018
44,562	39,421	45,476

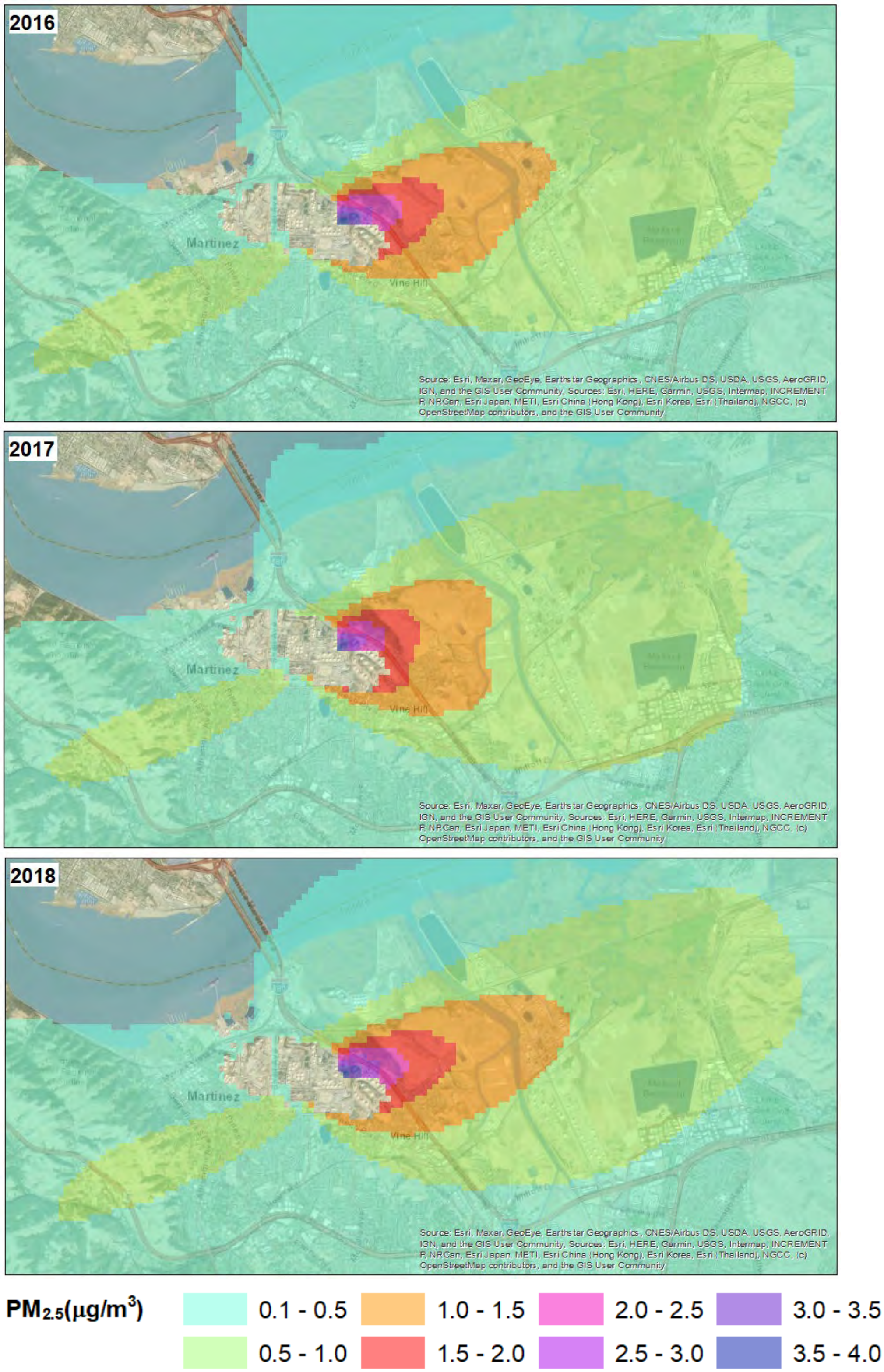

Figure D.3: Annual average CALPUFF-simulated $PM_{2.5}$ concentrations for 2016, 2017, and 2018 for a subset of the 100-m receptor domain that includes high-concentration areas. $PM_{2.5}$ emissions from all PBF point sources were included in these simulations.

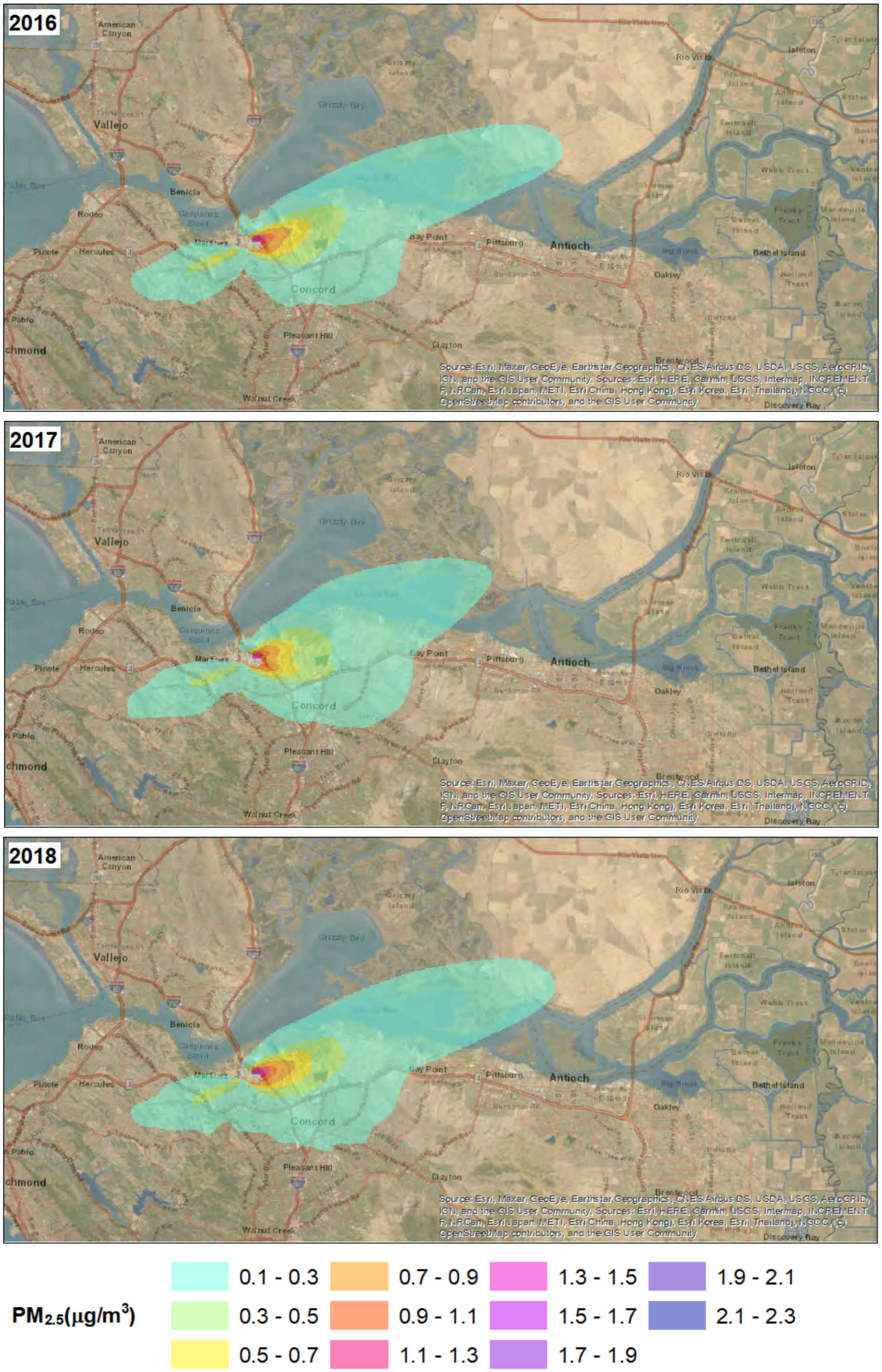

Figure D.4: Annual average CALPUFF-simulated $PM_{2.5}$ concentrations for the 100-m receptor domain for 2016, 2017, and 2018. $PM_{2.5}$ emissions from the FCCU only (without a WGS) were included in these simulations.

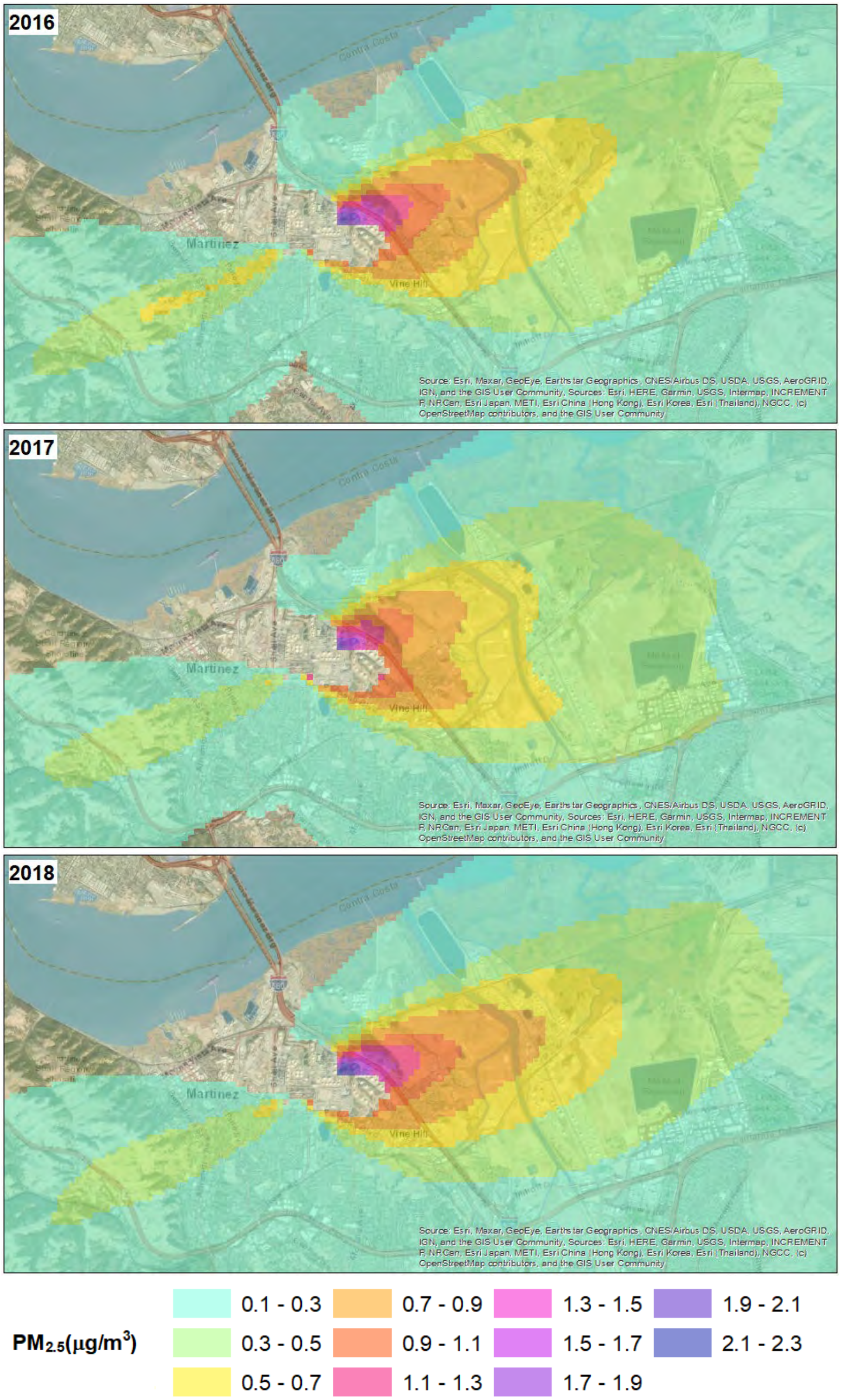

Figure D.5: Annual average CALPUFF-simulated $PM_{2.5}$ concentrations for 2016, 2017, and 2018 for a subset of the 100-m receptor domain that includes high-concentration areas. $PM_{2.5}$ emissions from the FCCU only (without a WGS) were included in these simulations.

APPENDIX B

SOURCE TEST RESULTS FROM PETROLEUM REFINERY FLUIDIZED CATALYTIC CRACKING UNITS THROUGHOUT THE UNITED STATES

Air District staff reviewed available data on total particulate matter emissions from fluidized catalytic cracking units at refineries throughout the United States. A summary of the relevant data and results and is shown below in Table B.1.

Table B.1 – Source Test Results from Petroleum Refinery Fluidized Catalytic Cracking Units Throughout the United States

Refinery/Unit	Agency	Test Methods	Test Date(s)	Total PM_{10} (gr/dscf)	Total PM_{10} @ 5% O_2 (gr/dscf)	Primary PM Control Technology
BP Whiting, IN - FCU 500	US EPA	EPA 5 and 201A/202	6/9/11 & 8/2/11	0.020	0.016	ESP
BP Whiting, IN - FCU 500	Indiana DEM	EPA 201A/202	4/14/16 - 4/15/16	0.026	0.021	ESP
BP Whiting, IN - FCU 500	Indiana DEM	EPA 201A/202	8/16/16 - 8/18/16	0.020	0.016	ESP
BP Whiting, IN - FCU 500	Indiana DEM	EPA 201A/202	4/20/18 & 4/23/18	0.026	0.022	ESP
BP Whiting, IN - FCU 500	Indiana DEM	EPA 201A/202	6/5/19 - 6/6/19	0.016	0.014	ESP
BP Whiting, IN - FCU 600	Indiana DEM	EPA 201A/202	4/19/16 - 4/20/16	0.024	0.020	ESP
BP Whiting, IN - FCU 600	Indiana DEM	EPA 201A/202	8/22/16 - 8/23/16	0.019	0.016	ESP
BP Whiting, IN - FCU 600	Indiana DEM	EPA 201A/202	5/17/17 - 5/18/17	0.018	0.015	ESP
BP Whiting, IN - FCU 600	Indiana DEM	EPA 201A/202	4/25/18 - 4/26/18	0.009	0.007	ESP
BP Whiting, IN - FCU 600	Indiana DEM	EPA 201A/202	6/12/19 - 6/13/19	0.006	0.005	ESP
Chevron Kapolei, HI	US EPA, Hawaii DOH	EPA 5 and 201A/202	6/24/11 - 6/26/11	0.014	0.014	ESP
Chevron Salt Lake Refinery, UT	Utah DEQ	EPA 201A/202	12/10/14	0.009	0.007	ESP
Chevron Salt Lake Refinery, UT	Utah DEQ	EPA 201A/202	8/3/17	0.026	0.022	ESP
CITGO Corpus Christi East Refinery, TX	Texas CEQ	EPA 5/202	8/21/18	0.031	0.024	ESP
CITGO - Lake Charles, LA	USEPA	EPA 5B/202	5/26/11 - 5/27/11	0.010	N/A[a]	WGS
ExxonMobil Baton Rouge Refinery, LA	Louisiana DEQ	EPA 5/202	5/23/12	0.040	0.032	WGS
ExxonMobil Baton Rouge Refinery, LA	Louisiana DEQ	EPA 5/202	11/21/13 - 11/22/13	0.032	0.026	WGS
ExxonMobil Baton Rouge Refinery, LA	Louisiana DEQ	EPA 5/202	6/16/15 - 6/17/15	0.036	0.030	WGS
ExxonMobil Baton Rouge Refinery, LA	Louisiana DEQ	EPA 5/202	11/18/15	0.027	0.023	WGS
ExxonMobil Baton Rouge Refinery, LA	Louisiana DEQ	EPA 5/202	4/20/17	0.020	0.016	WGS
ExxonMobil Baton Rouge Refinery, LA	Louisiana DEQ	EPA 5/202	11/15/17	0.032	0.026	WGS
ExxonMobil Baton Rouge Refinery, LA	Louisiana DEQ	EPA 5/202	1/28/20 - 1/29/20	0.078	0.065	WGS
ExxonMobil Torrance, CA	US EPA	EPA 201A/202	6/30/11	0.010	0.010	ESP
Flint Hills Resources, LP - Pine Bend, MI	Minnesota Pollution Control Agency	EPA 201A/202	11/2/11 - 11/3/11	0.019	0.018	ESP

Refinery/Unit	Agency	Test Methods	Test Date(s)	Total PM_{10} (gr/dscf)	Total PM_{10} @ 5% O_2 (gr/dscf)	Primary PM Control Technology
Flint Hills Resources, LP - Pine Bend, MI	Minnesota Pollution Control Agency	EPA 201A/202	8/20/14 - 8/22/14	0.016	N/A[a]	ESP
Flint Hills Resources, LP - Pine Bend, MI	Minnesota Pollution Control Agency	EPA 201A/202	6/27/17 - 6/29/17	0.019	0.018	ESP
HollyFrontier Woods Cross, UT - Unit 4 FCC #1	Utah DEQ	EPA 5B/202	12/20/12	0.004	0.004	WGS
HollyFrontier Woods Cross, UT - Unit 4 FCC #1	Utah DEQ	EPA 5/202	10/22/15	0.003	0.002	WGS
HollyFrontier Woods Cross, UT - Unit 4 FCC #1	Utah DEQ	EPA 5/202	10/2/14 - 10/3/14	0.005	0.004	WGS
HollyFrontier Woods Cross, UT - Unit 25 FCC #2	Utah DEQ	EPA 5/202	9/14/16 - 9/15/16	0.008	0.006	WGS
HollyFrontier Woods Cross, UT - Unit 25 FCC #2	Utah DEQ	EPA 5/202	10/31/17	0.010	0.009	WGS
HollyFrontier Cheyenne Refining, WY	Wyoming DEQ	EPA 5/202	3/3/17	0.002	0.002	WGS
HollyFrontier Cheyenne Refining, WY	Wyoming DEQ	EPA 5/202	11/8/17	0.007	0.006	WGS
HollyFrontier Cheyenne Refining, WY	Wyoming DEQ	EPA 5/202	8/22/18	0.006	0.004	WGS
HollyFrontier Cheyenne Refining, WY	Wyoming DEQ	EPA 5/202	7/24/19	0.008	0.007	WGS
Hovensa - US Virgin Islands	US EPA	EPA 5/202	6/18/11 - 6/19/11	0.017	0.014	WGS
Marathon - Robinson, IL	US EPA	EPA 5/202	7/19/11	0.028	0.026	WGS
Marathon - Detroit, MI	US EPA	EPA 5F/202	4/24/12	0.033	0.028	ESP
Marathon - Detroit, MI	US EPA	EPA 5F/202	4/25/12	0.025	0.021	ESP
Marathon - Detroit, MI	US EPA	EPA 5F/202	4/26/12	0.026	0.022	ESP
Marathon - Detroit, MI	Michigan DEQ	EPA 5F/202	11/18/14	0.019	0.017	ESP
Marathon - Detroit, MI	Michigan DEQ	EPA 5F/202	11/19/14 - 11/20/14	0.022	0.019	ESP
Marathon - Detroit, MI	Michigan DEQ	EPA 5F/202	9/1/15	0.027	0.022	ESP
Marathon - Detroit, MI	Michigan DEQ	EPA 5F/202	8/30/16 - 8/31/16	0.043	0.035	ESP
Marathon - Detroit, MI	Michigan DEQ	EPA 5F/202	8/31/16 - 9/1/16	0.042	0.035	ESP
Marathon - Detroit, MI	Michigan DEQ	EPA 5F/202	2/28/17	0.030	0.025	ESP
Marathon - Detroit, MI	Michigan DEQ	EPA 5F/202	2/13/18 - 2/14/18	0.035	0.033	ESP
Marathon - Detroit, MI	Michigan DEQ	EPA 5F/202	3/13/19	0.012	0.010	ESP
Marathon Refining - Galveston Bay, TX	Texas CEQ	EPA 5/202	6/30/16	0.020	0.018	WGS
Marathon Refining - Garyville, LA	US EPA	EPA 5/202	3/18/14 - 3/19/14	0.010	0.008	WGS
Marathon Refining - Garyville, LA	Louisiana DEQ	EPA 5/202	10/25/17	0.004	0.003	WGS
Marathon Refining - Garyville, LA	Louisiana DEQ	EPA 5/202	11/6/18	0.004	0.004	WGS

Refinery/Unit	Agency	Test Methods	Test Date(s)	Total PM_{10} (gr/dscf)	Total PM_{10} @ 5% O_2 (gr/dscf)	Primary PM Control Technology
Marathon Refining - Garyville, LA	Louisiana DEQ	EPA 5/202	10/12/19	0.005	0.004	WGS
Sunoco - Girard Point Philadelphia, PA	US EPA	EPA 5/202	6/24/11	0.034	N/A[a]	WGS
Tesoro Salt Lake City Refinery, UT	Utah DEQ	EPA 5/202	11/8/19 - 11/9/19	0.016	0.014	WGS[b]
Tesoro Salt Lake City Refinery, UT	Utah DEQ	EPA 5/202	2/19/19 - 2/20/19	0.025	0.024	WGS[b]
Tesoro Salt Lake City Refinery, UT	Utah DEQ	EPA 5/202	9/20/18	0.005	0.004	WGS[b]
Tesoro Salt Lake City Refinery, UT	Utah DEQ	EPA 5/202	8/24/18	0.013	0.012	WGS[b]
Tesoro Salt Lake City Refinery, UT	Utah DEQ	EPA 201A/202	8/8/17	0.041	0.037	ESP
Tesoro Salt Lake City Refinery, UT	Utah DEQ	EPA 201A/202	8/18/16	0.022	0.020	ESP
Tesoro Salt Lake City Refinery, UT	Utah DEQ	EPA 201A/202	7/7/15	0.019	0.017	ESP
Tesoro Salt Lake City Refinery, UT	Utah DEQ	EPA 201A/202	7/11/12	0.030	0.034	ESP
Valero - Port Arthur, TX	US EPA	EPA 5/202	6/13/11 - 6/14/11	0.008	0.007	WGS

[a] No oxygen information available in source test report.
[b] Tesoro Salt Lake City Refinery began operation of a WGS system to abate FCCU emissions in 2018.

March 30, 2021

Socioeconomic Impact Analysis of Proposed Amendments to Rule 5, Regulation 6: Particulate Emissions from Petroleum Refinery Fluidized Catalytic Cracking Units

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APPLIED DEVELOPMENT ECONOMICS

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1. INTRODUCTION

The Bay Area Air Quality Management District (Air District) has developed amendments to Regulation 6: Particulate Matter, Rule 5: Particulate Emissions from Petroleum Refinery Fluidized Catalytic Cracking Units (Rule 6-5). The purpose of these amendments is to address particulate matter from refinery fluidized catalytic cracking units (FCCU), which are some of the largest individual sources of particulate matter emissions in the San Francisco Bay Area. The Bay Area does not currently attain all state and national ambient air quality standards for particulate matter, and further reductions of particulate matter emissions are needed to ensure attainment and maintenance of the standards. Furthermore, exposure to particulate matter has long been understood as a health hazard based on respiratory health effects, and research has linked particulate matter exposure to a wide range of cardiovascular diseases, impacts to cognitive function, and cancer.

Fluidized catalytic cracking units are the largest single source of particulate matter emissions at petroleum refineries. Prior regulation of FCCUs only considered particulate matter that could be captured using filter-based test methods—filterable particulate matter. The evolution in our understanding of particulate formation and measurement methods has shown that this previous approach neglects to include the particulate matter that can form when the emissions from the stack cool upon contact with the atmosphere—condensable particulate matter. In 2010, the United States Environmental Protection Agency completed updates to test methods that can measure total particulate matter (both filterable and condensable particulate matter) emissions from sources such as FCCUs. Application of these updated methods at FCCUs have further indicated that a substantial fraction of the total particulate matter can be missed when using only filter-based test methods. The adoption of Air District Rule 6-5 in 2015 marked the first regulatory step in addressing condensable particulate matter from these fluidized catalytic cracking units in the San Francisco Bay Area. In 2017, the Air District's Clean Air Plan included a control measure to evaluate ongoing progress in reducing these emissions, and to further control particulate matter emissions from fluidized catalytic cracking units. In 2018, the Air District adopted the Expedited Best Available Retrofit Control Technology (BARCT) Implementation Schedule, which identified potential rule development projects to evaluate and implement Best Available Retrofit Control Technology at certain industrial sector facilities pursuant to California Assembly Bill 617 (AB 617). The schedule identified that potentially substantial particulate matter emission reductions could be achieved at these fluidized catalytic cracking units, and further rule amendments should be evaluated and considered. This current rule development effort for amendments to Rule 6-5 follows these previous Air District rulemaking and planning actions to address emissions from these sources.

After this introduction, this report discusses in greater detail proposed amendments to Rule 6-5 (Section Two). After that discussion, the report describes the socioeconomic impact analysis methodology and data sources (Section Three). The report describes population and economic trends in the nine-county San Francisco Bay Area (Section Four), which serves as a backdrop against which the Air District is contemplating the rule. Finally, the socioeconomic impacts stemming from the proposed rule changes are discussed in Section Five. The report is prepared pursuant to Section 40728.5 of the California Health and Safety Code, which requires an assessment of socioeconomic impacts of proposed air quality rules and amendments. The findings in this report can assist Air District staff in understanding the socioeconomic impacts of the proposed requirements, and can assist staff in preparing a refined version of the rule.

2. BACKGROUND AND OVERVIEW OF AMENDMENTS TO RULE 6-5

INTRODUCTION

Proposed amendments to Rule 6-5 would apply to fluidized catalytic cracking units (FCCU) and associated carbon monoxide boilers at Bay Area petroleum refineries. Four of the five petroleum refineries in the San Francisco Bay Area operate fluidized catalytic cracking units. These are Chevron Products Company (BAAQMD Plant #10 in Richmond), PBF Energy Martinez Refinery (BAAQMD Plant #11 in Martinez), Marathon Petroleum Corporation (BAAQMD Plant #14628 in Martinez), and Valero Refining Company (BAAQMD Plant #12626 in Benicia). The Valero refinery is anticipated to be able to comply with the rule amendments without significant additional cost expenditures. The Marathon refinery is not currently in operation. However, if it were to resume operations, it would be subject to the proposed Rule 6-5 amendments.

FCCU PROCESS DESCRIPTION

The proposed amendments to Rule 6-5 establish and modify FCCU emission standards for ammonia slip, sulfur dioxide, and total particulate matter. FCCUs are complex processing units at refineries that convert heavy components of crude oil into lighter distillates, including gasoline and other high-octane products. FCCUs use a fine powdered catalyst that behaves as a fluid when aerated with a vapor. The fluidized catalyst is circulated continuously between a reaction vessel where the catalyst is used to promote the hydrocarbon cracking process and a regenerator where carbonaceous material deposited on the catalyst is burned off.

The heated catalyst vaporizes the crude oil feed and brings the materials up to the desired cracking reaction temperature. As the cracking reaction progresses, the catalyst surface is gradually coated with carbonaceous material (coke), reducing its efficacy. The cracked hydrocarbon vapors are separated from the catalyst particles by cyclones in the reactor, and the hydrocarbon vapors are sent to a distillation column for separation and further processing.

The spent catalyst is steam stripped to remove remaining oil on the catalyst and cycled to the regenerator. The coke deposited on the catalyst is burned off in a controlled combustion process with preheated air, reactivating the spent catalyst. The catalyst is then recycled to be mixed with fresh hydrocarbon feed. Catalyst regenerators may be designed to burn the coke completely to carbon dioxide (CO_2) (full burn) or to only partially burn the coke to a mixture of carbon monoxide (CO) and carbon dioxide (partial burn). Because the flue gas from partial burn regenerators have high levels of carbon monoxide, the flue gas is vented to a carbon monoxide gas boiler where the carbon monoxide is further combusted to carbon dioxide.

The FCCU regenerator is a substantial source of emissions and fluidized catalytic cracking units are the largest single source of particulate matter emissions at petroleum refineries. During the regeneration process, some of the catalyst becomes entrained in the flue gas that exits the fluidized catalytic cracking unit regenerator. In addition to these “catalyst fines”, the flue gas also contains other pollutants, including sulfur dioxide (SO_2), oxides of nitrogen (NOx), reactive organic gases (ROG), toxic air contaminants, and other particulate matter (PM) generated in the combustion process. This flue gas is then routed through a train of pollutant abatement devices. In many abatement trains, ammonia (NH_3) is also injected into the flue gas stream to enhance the efficiency of certain types of pollution control equipment. Ammonia that is not fully consumed in the process can also remain in the flue gas stream (also referred to as “ammonia slip”) and may be emitted along with other pollutants in the flue gas. These gaseous pollutants can contribute to the formation of condensable particulate matter in the atmosphere. When released from the stack, these condensable components can form various particles, including ammonium nitrates and ammonium sulfates.

EMISSION CONTROL STRATEGIES FOR FCCU PARTICULATE MATTER

Reduction of Ammonia Injection and Ammonia Slip

Ammonia is commonly used as a conditioning agent to alter the resistivity and cohesiveness of particles in the gas stream, which can improve the effectiveness of electrostatic precipitators (ESP) in capturing catalyst fines. Excess ammonia that is not consumed in this process can remain in the FCCU flue gas stream (as ammonia slip) and can lead to the formation of condensable particulate matter. Therefore, reducing ammonia injection and ammonia slip can reduce emissions of condensable particulate matter. Potential strategies for achieving these reductions include:

- the optimization of ammonia injection
- the use of alternative non-ammonia conditioning agents
- and improved removal of particulate matter through electrostatic precipitators or wet gas scrubbing, which may reduce or eliminate the need for ammonia injection.

Some of these control strategies may also be used in combination to effectively reduce emissions of condensable particulate matter. The operation of electrostatic precipitators and wet gas scrubbers are described in more detail below. BAAQMD staff anticipate three of the affected refineries may need to install wet gas scrubbing to meet the proposed Rule 6-5 standards.

Electrostatic Precipitator

An electrostatic precipitator (ESP) is a control device designed to remove particulate matter from an exhaust gas stream by using electrical energy. The main components of the electrostatic precipitator include discharge electrodes, collection plates, and a plate cleaning system. Particulate matter is removed from the gas stream through a series of steps inside the electrostatic precipitator: 1) a power supply energizes the discharge electrodes to establish an electric field; 2) the gas stream and particles are ionized and charged as they pass through the electric field; 3) the charged particles migrate out of the gas stream and towards collection plates, which are oppositely charged; and 4) the particles collected on the plates are removed for disposal. The removal of particles from the collection plates can be accomplished using different systems. In a dry electrostatic precipitator system, rapping systems are used to vibrate the collection plates and remove the collected particles. In a wet electrostatic precipitator system, particles are removed from the collection plates by rinsing the plates with water.

Ammonia is often injected into flue gas streams to improve the collection efficiency of the electrostatic precipitators, however excess ammonia in the flue gas stream can contribute to condensable particulate matter formation. An electrostatic precipitator system with sufficient collection efficiency and capacity may be able to reduce or eliminate the need for ammonia injection, therefore limiting the amount of potential condensable particulate matter formation. The collection efficiency of an electrostatic precipitator system can be improved by rebuilding the system with additional capacity or by adding additional cells to increase residence time and collection surface area. In addition, advancements in electrostatic precipitator technologies can increase performance of existing systems, especially as these units and components age and degrade. For treatment of high-volume flue gas streams, installations of electrostatic precipitators typically require a large amount of space, although advancements in precipitator design and technology can reduce the size and space needed. Costs of new and expanded electrostatic precipitators can vary based on the specific installation, design, capacity, and other constraints.

Wet Gas Scrubbing

Wet gas scrubbing is a process that is used to remove liquid or solid particles from a gas stream. The process removes these particles by transferring them to a liquid, which is typically water or a reagent solution. In a typical wet gas scrubbing system, the scrubbing liquid is sprayed into the spray tower, and the flue gas stream enters at the bottom of the tower and flows upwards through the scrubbing liquid. As the gas stream passes through the scrubbing liquid, particles from the stream are collected as they impact the liquid droplets. Some wet gas scrubbing systems are also designed to capture gaseous pollutants that can be absorbed into the scrubbing liquid. The scrubbing liquid is then collected by mist eliminators or separators for treatment and discharge, or for regeneration and further use. Costs of new wet gas scrubbing systems can vary based on specific design and site constraints, as well as additional equipment or infrastructure required for operation.

Rule Amendments

The purpose of the proposed amendments to Rule 6-5 is to further address particulate matter emissions, including condensable particulate matter emissions, from fluidized catalytic cracking units and associated carbon monoxide boilers. The proposed amendments include new and modified limits on ammonia and sulfur dioxide, as well as a direct limit on total PM_{10}, which includes both filterable and condensable particulate matter. The proposed amendments also include a new limit on total PM_{10} emissions, which include both filterable and condensable particulate matter. This direct limit on total PM_{10} would ensure that both filterable and condensable particulate matter emissions are adequately controlled, and that abatement systems are optimized to reduce overall total particulate matter emissions. The proposed amendments also include modifications to existing rule language to clarify provisions and improve monitoring requirements.

3. METHODOLOGY

Applied Development Economics (ADE) began this analysis by preparing a statistical description of the industry groups of which the affected sources are a part, analyzing data on the number of establishments, jobs, and payroll. We also estimated sales generated by impacted industries, as well as net profits for each affected industry.

This report relies heavily on the most current data available from a variety of sources, including Corporate reports filed with the Securities Exchange Commission (SEC), data from the US Census County Business Patterns and Census of Manufactures, the US Internal Revenue Service, and reports published by the California Energy Commission (CEC) that track gasoline prices and cost components as well as refinery production levels. ADE also utilized employment data from the California Employment Development Department – Labor Market Information Division (EDD LMID).

With the above information, ADE was able to estimate net after tax profit ratios for sources affected by the proposed rule. ADE calculated ratios of profit per dollar of revenue for affected industries. The result of the socioeconomic analysis shows what proportion of profits the compliance costs represent. Based on assumed thresholds of significance, ADE discusses in the report whether the affected sources are likely to reduce jobs as a means of recouping the cost of rule compliance or as a result of reducing business operations. In some instances, particularly where consumers are the ultimately end-users of goods and services provided by the affected sources, we also analyzed whether costs could be passed to households in the region.

When analyzing the socioeconomic impacts of proposed new rules and amendments, ADE attempts to work closely within the parameters of accepted methodologies discussed in a 1995 California Air Resources Board (ARB) report called "Development of a Methodology to Assess the Economic Impact Required by SB513/AB969" (by Peter Berck, PhD, UC Berkeley Department of Agricultural and Resources Economics, Contract No. 93-314, August, 1995). The author of this report reviewed a methodology to assess the impact that California Environmental Protection Agency proposed regulations would have on the ability of California businesses to compete. The ARB has incorporated the methodologies described in this report in its own assessment of socioeconomic impacts of rules generated by the ARB. One methodology relates to determining a level above or below which a rule and its associated costs is deemed to have significant impacts. When analyzing the degree to which its rules are significant or insignificant, the ARB employs a threshold of significance that ADE follows. Berck reviewed the threshold in his analysis and wrote, "The Air Resources Board's (ARB) use of a 10 percent change in [Return on Equity] ROE (i.e. a change in ROE from 10 percent to a ROE of 9 percent) as a threshold for a finding of no significant, adverse impact on either competitiveness or jobs seems reasonable or even conservative."

4. ECONOMIC AND DEMOGRAPHIC TRENDS

This section of the report discusses the larger context within which the Air District is contemplating the proposed Rule 6-5 amendments. This section begins with a broad overview of demographic and economic trends, with discussion then narrowing to industries and sources affected by the proposed rule changes.

REGIONAL POPULATION TRENDS

Table 1 tracks population growth in the nine-county San Francisco Bay Area between 2008 and 2019, including data for the year 2015. Between 2008 and 2015, the region grew by 0.6 per year, compared to 0.3 percent for the state as a whole. Since 2015, the Bay Area region has had the same growth rate as the state. Overall, there are 7,790,537 people in the region. At 1,961,969, Santa Clara County has the most people, while Napa has the least, at 139,088. Contra Costa grew the fastest between 2008 and 2019, at 1.2 percent a year, while Sonoma and Napa both grew the least, at 0.2 percent per year.

Table 1: Population Trends: Bay Area Counties, Region, and California, 2008-2019

Jurisdiction	2008	2015	2019	08-15 CAGR	15-19 CAGR	08-19 CAGR
California	38,292,687	39,131,307	39,782,870	0.3%	0.4%	0.5%
SF Bay Area	7,375,678	7,671,279	7,790,537	0.6%	0.4%	0.8%
Alameda	1,556,657	1,632,599	1,670,834	0.7%	0.6%	1.0%
Contra Costa	1,060,435	1,128,405	1,153,561	0.9%	0.6%	1.2%
Marin	258,618	263,327	260,831	0.3%	-0.2%	0.1%
Napa	137,571	141,607	139,088	0.4%	-0.4%	0.2%
San Francisco	845,559	872,723	897,806	0.5%	0.7%	0.9%
San Mateo	745,858	767,921	773,244	0.4%	0.2%	0.5%
Santa Clara	1,857,621	1,931,565	1,961,969	0.6%	0.4%	0.8%
Solano	426,729	430,530	440,224	0.1%	0.6%	0.4%
Sonoma	486,630	502,602	492,980	0.5%	-0.5%	0.2%

Source: ADE, Inc., based on California Dept. of Finance E-5 Reports (note: CAGR = compound annual growth rate)

REGIONAL ECONOMIC TRENDS

Data in Table 2 describe the larger economic context within which officials are contemplating the proposed Rule 6-5 amendments. Businesses in the region employ almost 4.1 million workers. The number of jobs in the region grew annually by 1.3 percent between 2008 and 2015, the period that included the Great Recession. This was almost twice the rate of job growth statewide during this period. Since 2015, the region's job growth has accelerated to 2.4 percent per year, compared to 2 percent for the state.

The economic sectors in Table 2 are sorted by the share of total employment in 2019. The top-five sectors in the Bay Area in terms of total number of workers are Professional and Business Services (NAICS 54-55) (699,300 workers) which includes many technology businesses, Educational and Health Services (NAICS 61-62) (615,127 workers), Government (483,343), which also includes public sector health and education jobs, Leisure and Hospitality (NAICS 71-72) (444,809), and Manufacturing (NAICS 31-33), which includes the petroleum refineries subject to Rule 6-5.

Table 2: San Francisco Bay Area Employment Trends By Sector: 2008 - 2019

Industry Sector		2008	2015	2019	2019	2019 CA	SFBA CAGR* 08-15	SFBA CAGR 15-19	CA CAGR 08-15	CA CAGR 15-19
Total, All Industries		**3,377,300**	**3,692,400**	**4,066,566**	**100.0%**	**100.0%**	**1.3%**	**2.4%**	**0.7%**	**2.0%**
54-55	Professional & Business Services	593,200	699,300	779,697	19.2%	15.2%	2.4%	2.8%	1.5%	2.2%
61-62	Educational & Health Services	455,600	550,500	615,127	15.1%	15.7%	2.7%	2.8%	2.7%	3.3%
90	Government	478,400	466,200	483,343	11.9%	14.6%	-0.4%	0.9%	-0.3%	1.4%
71-72	Leisure & Hospitality	336,300	405,700	444,809	10.9%	11.4%	2.7%	2.3%	2.2%	2.7%
31-33	Manufacturing	342,900	334,300	364,122	9.0%	7.4%	-0.4%	2.2%	-1.3%	0.4%
44-45	Retail Trade	333,500	341,400	341,627	8.4%	9.3%	0.3%	0.0%	0.2%	0.0%
51	Information	118,100	166,000	233,607	5.7%	3.2%	5.0%	8.9%	0.4%	3.6%
21,23	Mining, Logging, and Construction	179,600	174,300	209,758	5.2%	5.1%	-0.4%	4.7%	-1.0%	4.5%
52-53	Financial Activities	188,100	187,400	200,793	4.9%	4.7%	-0.1%	1.7%	-0.7%	1.2%
81	Other Services	112,900	122,900	130,946	3.2%	3.2%	1.2%	1.6%	0.9%	1.5%
22,48	Transportation, Warehousing & Utilities	93,300	99,700	121,850	3.0%	3.9%	1.0%	5.1%	1.4%	5.9%
42	Wholesale Trade	125,600	125,200	121,205	3.0%	3.9%	0.0%	-0.8%	0.0%	0.1%
11	Farm	20,000	19,900	20,280	0.5%	2.4%	-0.1%	0.5%	1.2%	0.1%

*Source: Applied Development Economics, based on State of California, Employment Development Department Labor Market Information Division, "Quarterly Census of Employment and Wages" *Note: CAGR = compound annual growth rate; **Note: Public sector education and public sector health included in government.*

The fastest job growth rates since 2015 have been in Information Services, which includes many internet businesses, followed by Transportation, Warehousing and Utilities, Construction, Professional and Business Services and Health Care.

The table demonstrates the advanced nature of the regional economy, as one quarter of all workers are in the combined Professional, Business and Information Services, compared 18.4 percent for the state. Interestingly, at 2.2 percent per year between 2015 and 2019, manufacturing employment growth in the Bay Area five times faster than statewide manufacturing growth rates (0.4 percent), underscoring the diversity of the regional economy.

TRENDS FOR INDUSTRIES SUBJECT TO PROPOSED RULE 6-5 AMENDMENTS

Proposed amendments to Rule 6-5 affect petroleum refineries (NAICS 324110) of which there are five in the Bay Area. The most recent employment data available for the refineries indicates there were 3,536 workers directly employed at the facilities in 2018 (Table 3). Refinery jobs have been growing slowly since 2014, but have not recovered to the 2009 level of nearly 4,000 jobs at the beginning of the Great Recession.

Table 3: Employment Trends for Large Refineries in the San Francisco Bay Area: 2009-2018

YEAR	JOBS
2009	3,976
2010	3,622
2011	3,620
2012	3,542
2013	3,726
2014	3,269
2015	3,440
2016	3,464
2017	3,503
2018	3,536

Source: Applied Development Economics, based on US Census County Business Patterns 2009-2018.

With the current recession starting in 2020 due to the Covid-19 pandemic, it may be expected that refinery production levels will be affected, with associated financial impacts and job reductions at the facilities. Shelter in place orders that have reduced commute and shopping travel have dramatically reduced demand for gasoline. ADE researched refinery operations during past recessions to see how this industry has been affected. In the past 20 years there have been two major recessions, in 2001 and 2009.

According to the National Bureau of Economic Research (NBER), the 2001 recession began in March, 2001 and was short-lived, reaching its lowest point in November 2001. On a national level, between 2000 and 2001, the number of refineries declined by 17.5%, from 565 to 466. The number of refineries with positive net income declined even more, by 69.8%, from 538 to 162. By 2002, the number of refineries began to climb back to pre-2001 totals, reaching 524 refineries. However, in 2002, net income dropped to 4.2 percent of sales, down from 8.1 percent the prior year (Table 4).

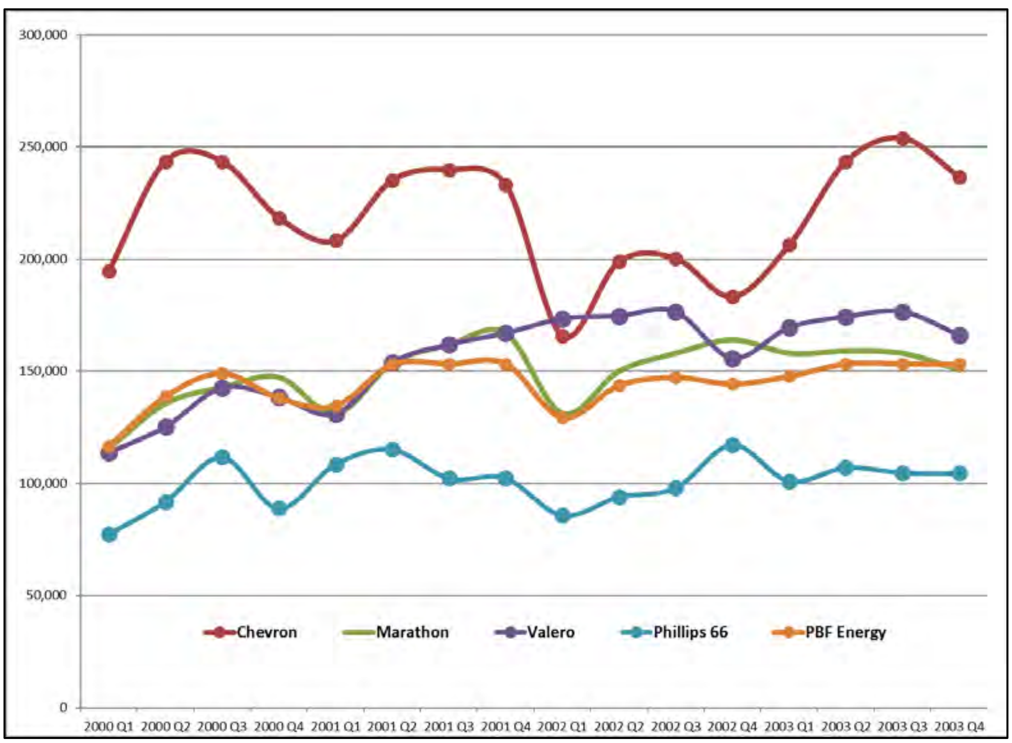
In the Bay Area, the five major refineries continued to operate, but the levels of production dipped in the first quarter of 2002 for all the refineries except Valero (Figure 1). Chevron and Valero both reduced production at the end of 2002, but by 2003 all of the refineries appear to have resumed normal production levels.

Table 4: Financial Data for US Refineries, 2000-2015

Year	Number of Returns: Total	Number of Returns: With Net Income	Total Receipts: All Returns ($000)	Total Receipts: Returns with Net Income ($000)	Net Income ($000)	Net Income as % of Receipts for All Returns
2000	565	538	$708,474,441		$62,708,199	8.9%
2001	466	162	$633,789,676	$605,081,480	$51,230,377	8.1%
2002	524	210	$669,958,738	$547,826,711	$28,399,114	4.2%
2003	321	33	$878,169,484	$762,432,630	$59,495,577	6.8%
2004	715	43	$1,233,451,434	$1,208,031,229	$101,033,255	8.2%
2005	1067	408	$1,586,371,810	$1,582,603,337	$136,076,434	8.6%
2006	928	171	$1,772,672,777	$1,760,205,082	$141,961,956	8.0%
2007	661	160	$1,885,776,974	$1,858,951,329	$139,936,842	7.4%
2008	569	150	$2,317,367,592	$2,272,108,356	$145,966,007	6.3%
2009	241	159	$1,467,910,148	$1,010,993,626	$103,847,446	7.1%
2010	246	169	$1,884,313,300	$1,471,175,784	$133,408,355	7.1%
2011	202	162	$2,405,497,424	$2,323,700,453	$128,065,951	5.3%
2012	217	159	$2,396,760,591	$2,113,571,335	$152,741,615	6.4%
2013	207	67	$2,202,152,058	$1,894,102,850	$123,956,446	5.6%
2014	203	161	$2,085,986,718	$1,781,343,053	$103,077,549	4.9%
2015	143	116	$1,329,920,999	NA	$67,026,843	5.0%

Source: Internal Revenue Service

Figure 1: Bay Area Refinery Production Levels, 2001 Recession

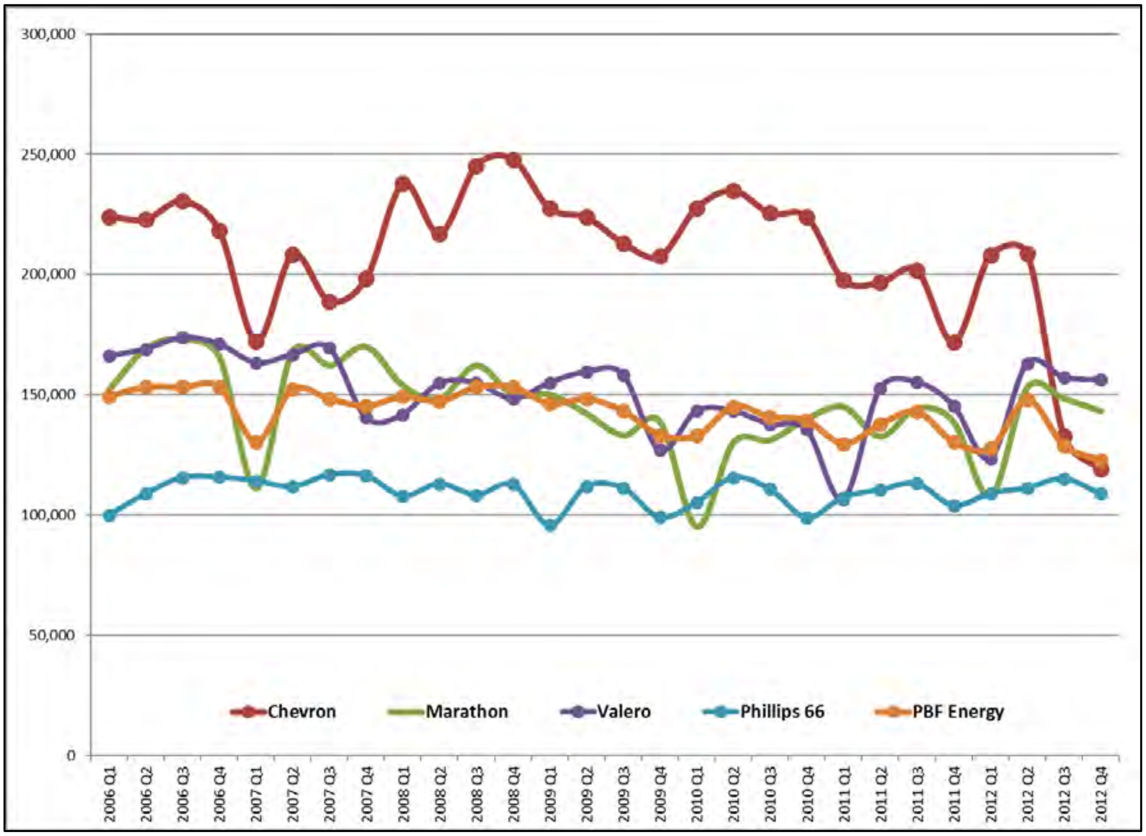


Source: ADE, based on data from corporate reports. Note, the names shown for the refineries reflect current ownership, not necessarily the ownership in 2000-2003.

According to the NBER, the 2008 Great Recession began officially in December 2007, and extended downward to its lowest point in in June 2009. But the actual recovery after June 2009 was "flat", in contrast to the earlier 2001 recession. The full effect of the recession that began in December 2007 became evident in 2009, when there were 241 US refineries as compared to 569 in 2008, for a loss of 57.6% (Table 4). Average net income per refinery went from $973 million to $653 million for a 32.8% decline, although net income as a percent of sales did not decline as much as in 2002. In 2008 it was 6.3 percent, down from 8.0 percent in 2006. However, this figure has never again reached 8.0 percent on a national level. Also, in the years immediately prior to and including 2008, there were 928 US refineries in 2006 and 661 in 2007. Since 2009, there have consistently been less than 300.

At the Bay Area refineries, production levels had dropped at the beginning of 2007 and did not really show the effects of the recession until late 2009, with additional dips in 2012 (Figure 2).

Figure 2: Production Levels at Bay Area Refineries, 2006-2012



Source: ADE, based on data from corporate reports. Note, the names shown for the refineries reflect current ownership, not necessarily the ownership in 2006-2012.

In 2017, the US Bureau of the Census counted 18 refineries in California. In aggregate, the net income for these facilities was 4.1 percent of sales (Table 5), slightly lower than the national figure of 5.0 percent in 2015.

Table 5: Operating Characteristics for California Refineries, 2017

Operating Parameter	2017 Value
Number of firms	11
Number of establishments	18
Sales, value of shipments, or revenue ($1,000)	$56,216,881
Annual payroll ($1,000)	$1,174,919
Total fringe benefits ($1,000)	$398,409
Total cost of supplies and/or materials ($1,000)	$46,126,161
Total capital expenditures for buildings, structures, machinery, and equipment (new and used) ($1,000)	$1,709,789
Total depreciation during year ($1,000)	$1,423,320
Total rental payments or lease payments ($1,000)	$118,057
Total other operating expenses ($1,000)	$2,950,272
Net operating income	$2,315,954
Percent of sales	4.1%

Source: ADE, Inc. based on 2017 Economic Census

Table 6 below identifies the businesses in the Bay Area that are full-scale refineries. The California Energy Commission (CEC) tracks each refinery's throughput capacity. Of the five operating refineries in the region, Chevron is the largest, with the capacity to refine 245,271 42-gallon barrels of crude oil per day (BPD). At 120,200, Phillips 66 has the lowest throughput capacity. The five affected sources employ approximately 3,500 workers, who make an average wage of $127,000, not including benefits, based on the data in Table 5.

Table 6: Bay Area Refineries (California Energy Commission) and Crude Oil Capacity

Refinery	Barrels Per Day
Chevron U.S.A. Inc., Richmond Refinery	245,271
Marathon Petroleum Corp., Golden Eagle (Avon/Rodeo) Refinery	161,500
PBF Energy, Martinez Refinery	156,400
Valero Benicia Refinery	145,000
Phillips 66, Rodeo San Francisco Refinery	120,200

Source: Applied Development Economics, Inc., based on California Energy Commission

The five affected sources' combined throughput capacity is approximately 828,371 42-gallon barrels per day (BPD). Based on average utilization rates for refineries as provided in the US Census of Manufactures, we estimate the actual effective throughput of the refineries is about 740,150 BPD.

Refined products exceeded the crude oil inputs by about 3.5 percent in 2019, resulting in an estimate of 766,055 BPD of refined products produced by the Bay Area refineries.[1]

Three of the refineries, Chevron, Marathon and PBF Energy, would potentially see increased costs from implementation of proposed amendments to Rule 6-5. For these refineries, we have estimated annual sales (revenues) and profit levels, for use in analysis of the economic impacts of the rule in the next section of the report (Table 7). The Marathon refinery is not currently in operation. However, if it were to resume operations, it would be subject to the Rule 6-5 amendments. We have analyzed the impact of the rule amendments on that refinery using the 2019 level of operations.

The effective BPD for each of the refineries shown in Table 7 is based on the factors described above. The revenue information is based on an estimate of the wholesale value of gasoline at $121.04, based on 2019 data provided by the CEC.[2] The net profits estimates are based on data from corporate reports for each of the petroleum companies, described further below. As discussed above, profit ratios for refineries have been declining since the Great Recession. The analysis described below suggests that for the Bay Area refineries, profit levels slipped below 3 percent by 2019. It may be expected that profits will drop further due to the Covid-19 pandemic. It is difficult to predict the time frame for recovery from this recession, as there remains much uncertainty on the ability of consumers and businesses to resume previous levels of economic activity given the significant loss of income. However, the requirements of the proposed amendments to Rule 6-5 would not take effect until approximately 2026. For purposes of this analysis, we use the 2019 financial performance of the refineries as a benchmark for the effects of the compliance costs in 2026.

Chevron Richmond. In its 2019 annual report, Chevron reports $1.559 billion in earnings from its US downstream refining operations. This was down from $2.1 billion in 2018, which Chevron ascribes to lower margins on sales for refined products, but also was affected by a higher depreciation expense of $100 million following first production at the new hydrogen plant at the Richmond refinery. Chevron reported sales of 1.250 (MBPD) of gasoline and other refined products. We estimate, then, that Chevron earned $1,247 per barrel per day (BPD) of refined product. This amount is applied to the output estimate in Table 7 of 226,820 BPD, resulting in an estimate of the net income from the Richmond refinery of $282.8 million. This is down from a 2017 estimate of $332.6 million, which was 4.1 percent of sales for that year. The current estimate is 2.8 percent of sales.

PBF Energy Martinez. PBF completed the purchase of this refinery from Shell in February 2020, so there is no 2019 operating or financial data for the refinery under PBF ownership. Consequently, we have reviewed the Shell annual report for 2019 to estimate the operating performance of the Martinez refinery.

Shell reported downstream refinery net earnings of $6.7 billion for all its refining operations, and indicates that 19 percent of its refined products sales occurred from US operations, so we have

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[1] California Energy Commission, Weekly Fuels Watch, 2019.

[2] California Energy Commission, Estimated 2019 Gasoline Price Breakdown and Margins Details.

prorated net earnings to $1.27 billion for US refineries. Shell reports that total US refining capacity was 1,117,000 barrels per day (BPD), which yields a return of $1,136 per BPD capacity, slightly below the comparable figure for Chevron.

Based on these factors, we estimate the net income from the Martinez refinery was $177.7 million, which is also lower than the 2017 estimate of $212.1 million for that facility. The 2019 net income represents 2.8 percent of estimated sales revenue.

The Martinez Refinery Company has indicated in written comments that the refinery and its parent company, PBF Energy, have experienced a significant downturn in demand in 2020 as a result of the Covid-19 pandemic, with substantial economic dislocations and revenue losses. We expect this is true for much of the refining industry. However, the implementation costs associated with amendments to Rule 6-5 are not scheduled to occur for several years, at which time the economy is projected to recover to near pre-pandemic levels. The present socioeconomic analysis, therefore, is based on financial indicators from the refinery in 2019.

Marathon Martinez. Marathon does not report net income per barrel in the same way as Chevron and Shell, but its 2019 Annual Report indicates that for all its refineries, sales revenue totaled $106,742 million and income from operations was $2,367 million. The net income ratio from these figures is 2.2 percent, which has been applied to the sales estimate in Table 7 to derive the net income figure for that refinery.

Table 7: Estimated Revenues and Net Profits for Refineries Affected by Rule 6-5 Amendments

	CHEVRON	MARATHON	PBF ENERGY
Refined Barrels Per Day	226,820	149,350	144,600
Est. Revenues	$10.0 billion	$6.6 billion	$6.4 billion
Est. Net Profits	$282.8 million	$146.5 million	$177.7 million

Source: ADE, Inc.

5. SOCIOECONOMIC IMPACT ANALYSIS OF PROPOSED AMENDMENTS TO RULE 6-5

This section of the report analyzes socioeconomic impacts stemming from proposed amendments to Rule 6-5. Air District staff identified two potential control scenarios in developing amendments to Rule 6-5: the Proposed Amendments and a Less Stringent Control Option. Estimated compliance costs associated with each of these control scenarios are described below.

Proposed Amendments to Rule 6-5 would impact FCCUs at the Chevron Richmond, Marathon Martinez, and PBF Martinez refineries. Staff anticipates that each of these refineries would be required to install a wet gas scrubbing (WGS) system to control emissions from their FCCUs. Estimated capital costs for installation and total annualized costs (including amortized capital costs [20-year lifetime at 6% interest], tax, insurance, general and administrative, and operating and maintenance costs) for the Proposed Amendments are shown in Table 8.

Table 8: Estimated Costs for Proposed Amendments to Rule 6-5 ($millions)

FACILITY	CAPITAL COSTS	TOTAL ANNUALIZED COSTS
Chevron Products Richmond	$241	$39
Marathon Martinez Refinery	$235	$38
PBF Martinez Refinery	$255	$40
Valero Benicia Refinery	–	–

Source: BAAQMD

The Less Stringent Control Option would impact FCCUs at the Chevron Richmond and PBF Martinez refineries. Staff anticipates that Chevron Richmond would be required to add additional electrostatic precipitator (ESP) capacity to the existing system. Staff anticipates that PBF would be required to add additional ESP capacity, and would also be required to improve existing systems to reduce SO_2 emissions. Staff anticipates this would include improvements to the current hydrotreater for FCCU feed, as well as improved SO_2-reducing additive operations using newer catalyst additive technologies. Estimated capital costs for installation and total annualized costs (including amortized capital costs [20-year lifetime at 6% interest], tax, insurance, general and administrative, and operating and maintenance costs) for the Less Stringent Control Option are shown in Table 9.

Table 9: Estimated Costs for Less Stringent Control Option ($millions)

Facility	Capital Costs	Total Annualized Costs
Chevron Products Richmond	$30	$4.4
Marathon Martinez Refinery	–	–
PBF Martinez Refinery	$80	$14
Valero Benicia Refinery	–	–

Source: BAAQMD

The methodology section above explains that compliance costs that exceed ten percent of return on equity have the potential to create significant adverse socioeconomic impacts on the affected facilities. The cost for the Less Stringent Control Option fall below this threshold, at 1.6 percent of net income for the Chevron refinery and 8.1 percent of the PBF Energy refinery, with no impact to the Marathon facility. However, the cost for the Proposed Amendments exceeds the threshold for all three refineries, reaching 13.7 percent of net income at Chevron, 25.8 percent for Marathon and 22.3 percent for PBF Energy (Table 10).[3]

Table 10: Impact of Rule 6-5 Amendments Annual Compliance Costs on Refinery Net Income

Refinery	Rule 6-5 Annual Cost Scenarios ($millions)		Annual Net Income ($millions)	Rule 6-5 Costs as a Percent of Net Income	
	Less Stringent Control Option	Proposed Amendments		Less Stringent Control Option	Proposed Amendments
Chevron U.S.A. Inc., Richmond	$4.4	$38.8	$282.8	1.6%	13.7%
Marathon, Golden Eagle (Avon/Rodeo)	–	$37.8	$146.5	0.0%	25.8%
PBF Energy, Martinez	$14.4	$39.6	$177.7	8.1%	22.3%

Source: ADE Inc.

Under the Proposed Amendments, the refineries would be expected to attempt to reduce other costs or increase revenues to restore the cost impact below ten percent of net income. The annual amounts necessary to achieve this result range from $10.5 million per year for Chevron to $23.1 million per year for Marathon.

Chevron U.S.A. Inc., Richmond	$10.5 million
Marathon, Golden Eagle (Avon/Rodeo)	$23.1 million
PBF Energy, Martinez	$21.8 million

There are several ways the companies could consider making these adjustments, although it is not clear if any are feasible at these plants. If the companies reduced labor costs in these amounts, it

[3] The portion of the annualized costs that relate to capital expenditures could be depreciated to reduce corporate taxes, which would reduce the impact of those expenditures by about 20 percent based on the average corporate tax rate.

would be equivalent to reducing employment by 62 jobs at Chevron, 136 jobs at Marathon and 128 jobs at PBF Energy. This may be feasible at Chevron, but such cuts would amount to an estimated 19-20 percent labor reduction at Marathon and PBF Energy. It is not clear whether the plants could operate at capacity with this level of staff reductions.

On the revenue side, the highest cost impact, which would occur at the PBF Energy refinery, would amount to 0.62 percent of estimated annual revenue at the plant (about six tenths of one percent or production over 2.25 days). Translated to the wholesale price for gasoline, this equals about $0.75 per barrel or $0.02 per gallon. While individual refineries are limited in their ability to increase prices unilaterally, particularly during a period of falling demand, it seems more likely the costs of the Proposed Amendments would result in an increase in gas prices rather than a significant loss of refinery jobs. The price increases required to reduce the significance of the emission reduction costs are well within the level of gas price fluctuations that normally occur due to changes in demand and supply factors annually.

Therefore, while the costs for the Proposed Amendments are potentially significant for the affected facilities, it is likely they can be mitigated to less than significant levels. The increase in gasoline prices would have multiplier effects in the regional economy as consumers shift spending from other sectors to increased transportation costs. However, it should be noted that the cost to purchase and install the required control technologies would translate to added jobs and income in the Bay Area region, offsetting much if not all of the impact of the increased gas prices on the regional economy.

Small Business Disproportionate Impacts

According to the State of California, among other things, small businesses generate annual sales of less than $10 million.[4] Of the eight sources affected by the proposed draft rule, none are small businesses. As a result, small businesses are not disproportionately impacted by proposed amendments to Rule 6-5.

[4] http://www.leginfo.ca.gov/cgi-bin/displaycode?section=gov&group=14001-15000&file=14835-14843

APPENDIX D

2018 FINAL ENVIRONMENTAL IMPACT REPORT – AB 617 EXPEDITED BEST AVAILABLE RETROFIT CONTROL TECHNOLOGY (BARCT) IMPLEMENTATION SCHEDULE

Response to Comments for the Final Environmental Impact Report for the Bay Area Air Quality Management District

AB 617 Expedited BARCT Implementation Schedule Project

State Clearing House Number: 2018082003

Prepared for:

Bay Area Air Quality Management District
375 Beale St., Suite 600
San Francisco, CA 94105
Contact: David Joe
(415) 749-8623

Prepared By:

Environmental Audit, Inc.
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Placentia, CA 92870
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(714) 632-8521

December 2018

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Response to Comments
Table of Contents

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TABLES:

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1.0 INTRODUCTION

This Final Environmental Impact Report (FEIR) has been prepared in accordance with the California Environmental Quality Act (CEQA) (Public Resources Code Section 21000 et seq.) and the CEQA Guidelines (California Code of Regulations Section 15000 et seq.). According to CEQA Guidelines, Section 15132, the FEIR shall consist of:

- The Draft Environmental Impact Report (DEIR) or a revision of the Draft;
- Comments and recommendations received on the DEIR either verbatim or in summary;
- A list of persons, organizations, and public agencies comments on the DEIR;
- The responses of the Lead Agency to significant environmental points raised in the review and consultation process; and,
- Any other information added by the Lead Agency.

This Response to Comments, together with other portions of the DEIR as revised, constitutes the FEIR for the proposed AB 617 Expedited Best Available Retrofit Control Technology (BARCT) Implementation Schedule.

The DEIR contains a detailed project description, the environmental setting for each of the environmental resources topic areas where the Notice of Preparation and Initial Study (NOP/IS) determined there was a potential significant adverse impact, an analysis of the potentially significant environmental impacts including cumulative impacts, project alternatives, mitigation measures, and other areas of discussion as required by CEQA. The discussion of the project-related and cumulative environmental impacts included a detailed analysis of air quality, hazards and hazardous materials, and hydrology and water quality.

The DEIR was released on October 23, 2018 and circulated for a 45-day public review and comment period that ended on December 7, 2018. The DEIR is available at the Bay Area Air Quality Management District (BAAQMD), 375 Beale Street, Suite 600, San Francisco, California 94105. Copies can also be obtained by accessing the BAAQMD's website at http://www.baaqmd.gov/ab617barct. The BAAQMD received one comment letter on the Draft EIR during the public comment period. The comment letters and responses to the comments raised in those letters are provided in this document. The comments are bracketed and numbered. The related responses are identified with the corresponding number and are included following each comment letter.

1.1 FORMAT OF THIS DOCUMENT

The Final EIR for the Expedited BARCT Implementation Schedule consists of the Draft EIR and its technical appendices; the Responses to Comments included herein; and other written documentation prepared during the EIR process. The District would also consider adoption of a Statement of Findings of Fact and a Statement of Overriding Considerations as part of the approval process for the Project.

This Response to Comments document is organized as follows:

- Section 1 provides a brief introduction to this document.
- Section 2 identifies the Draft EIR commenters.
- Section 3 provides responses to substantive comments received on the Draft EIR. Responses are provided in the form of individual responses to comment letters received. Comment letters are followed immediately by the responses to each letter.
- Section 4 presents clarifications to the Draft EIR, identifying revisions to the text of the document.

1.2 CEQA REQUIREMENTS REGARDING COMMENTS AND RESPONSES

CEQA Guidelines Section 15204 (a) outlines parameters for submitting comments, and reminds persons and public agencies that the focus of review and comment of DEIRs should be "on the sufficiency of the document in identifying and analyzing possible impacts on the environment and ways in which significant effects of the project might be avoided or mitigated. Comments are most helpful when they suggest additional specific alternatives or mitigation measures that would provide better ways to avoid or mitigate the significant environmental effects. At the same time, reviewers should be aware that the adequacy of an EIR is determined in terms of what is reasonably feasible. CEQA does not require a lead agency to conduct every test or perform all research, study, and experimentation recommended or demanded by commenters. When responding to comments, lead agencies need only respond to significant environmental issues and do not need to provide all information requested by reviewers, as long as a good-faith effort at full disclosure is made in the EIR."

CEQA Guidelines Section 15204 (c) further advises, "Reviewers should explain the basis for their comments, and should submit data or references offering facts, reasonable assumptions based on facts, or expert opinion supported by facts in support of the comments. Pursuant to Section 15064, an effect shall not be considered significant in the absence of substantial evidence." Section 15204 (d) also states, "Each responsible agency and trustee agency shall focus its comments on environmental information germane to that agency's statutory responsibility." Section 15204 (e) states, "This section shall not be used to restrict the ability of reviewers to comment on the general adequacy of a document or of the lead agency to reject comments not focused as recommended by this section."

2.0 COMMENTS RECEIVED ON THE DRAFT EIR

In accordance with the State CEQA Guidelines Section 15132, the following is a list of public agencies, organizations, individuals, and businesses that submitted comments on the Draft EIR received as of close of the public review period on December 7, 2018. Comments have been numbered and responses have been developed with corresponding numbers.

TABLE 2-1

Comment Letters with Responses Prepared

Comment Letter	Commenter	Date Received
1	Gordon Johnson, Shell Oil Products, U.S. Martinez Refinery	12/7/18

3.0 RESPONSES TO COMMENTS

This section includes responses to all substantive environmental issues raised in comments received on the Expedited Best Available Retrofit Control Technology (BARCT) Implementation Schedule. Responses are provided for each of the comments received. This section is formatted so that the respective comment letters are followed immediately by the corresponding responses. Comment letters and specific comments are given letters and numbers, respectively, for reference purposes.

Comment Letter No. 1

Shell Oil Products US

Martinez Refinery
PO Box 711
Martinez, CA 94553-0071

BY CERTIFIED MAIL AND EMAIL

December 07, 2018

Mr. David Joe
Office of Rules and Strategic Policy
Bay Area Air Quality Management District (BAAQMD)
375 Beale Street, Suite 600
San Francisco, CA 94105

Subject: Shell Comments on Staff Report and DEIR for AB 617 Expedited BARCT Implementation Schedule

Dear Mr. Joe:

The Shell Martinez Refinery (Shell) is writing this letter to provide comments on the revised Staff Report on the Assembly Bill 617 (AB 617) Expedited Best Available Retrofit Control Technology (BARCT) Implementation Schedule and Draft Environmental Impact Report (DEIR), dated October of 2018. 1-1

Staff Report

In a letter dated October 5, 2018, Shell provided BAAQMD comments on the prior Initial Staff Report issued in September of 2018. The comments in the October 5, 2018 letter are still applicable and are attached to this letter.

DEIR

Chapter 3.4 of the DEIR, "Hydrology and Water Quality," concludes that the installation and operation of a wet gas scrubber (WGS) to control sulfur oxide emissions would result in significant impacts on water demand. More specifically, the DEIR estimates the expected water demand may be up to 300 gallons per minute or 432,000 gallons per day for each WGS. The DEIR states that up to three WGS may be installed in the San Francisco Bay Area to comply with the proposed Expedited BARCT Implementation Schedule, which would result in total water demand of up to 1,296,000 gallons per day. Shell appreciates BAAQMD acknowledging the significant impact on water demand that would result from the installation and operation of a WGS. 1-2

However, the DEIR states, "it is not expected that wastewater would exceed a facility's current wastewater discharge limits, require changes to existing wastewater permit conditions, or require new wastewater permits" and that "water quality impacts during operation are concluded to be less than significant." These conclusions cannot be made without further analysis. For example, assuming that a new WGS system at Shell would generate up to 300 gallons per minute of new wastewater, Shell would need to upgrade the existing wastewater infrastructure to address potential sewer bottlenecks and overall capacity. In addition, Shell would need to update the National Pollutant Discharge Elimination

System (NPDES) permit to address the changes in the wastewater treatment system and potential increase in contaminants. BAAQMD should either perform a more complete analysis of water quality impacts to correctly characterize the impacts or, if information is not currently available to show otherwise, conclude that impacts on water quality may be potential significant.

Shell is looking forward to continuing to work with BAAQMD staff to further discuss these concerns and determine a path forward.

Please contact Rick Shih at 925-313-0586 if you would like to discuss these issues in more detail.

1-2 cont..

Very truly yours,

Gordon Johnson
Manager, Environmental
Shell Oil Products, US – Martinez Refinery

Attachment:

Shell Comment Letter Dated October 5, 2018

3

Shell Oil Products US

Martinez Refinery
PO Box 711
Martinez, CA 94553-0071

CERTIFIED MAIL AND EMAIL

October 05, 2018

Mr. David Joe
Office of Rules and Strategic Policy
Bay Area Air Quality Management District (BAAQMD)
375 Beale Street, Suite 600
San Francisco, CA 94105

Subject: Shell Comments on Initial Staff Report for AB 617 Expedited BARCT Implementation Schedule

Dear Mr. Joe,

The Shell Martinez Refinery (Shell) is writing this letter to provide comments on the Initial Staff Report on the Assembly Bill 617 (AB 617) Expedited Best Available Retrofit Control Technology (BARCT) Implementation Schedule (dated September of 2018). The focus of Shell's comments is on the Rule Development Project Scope for fluidized catalytic cracking units (FCCU) and carbon monoxide (CO) Boilers attached to the Initial Staff Report (referred to as Project Scope in this letter). Shell previously provided BAAQMD Shell's initial comments to the draft Project Scope issued in May of 2018. Those initial comments that are still applicable are also reiterated below. 1-3

Additional Studies Required Prior to Rule Implementation

The Staff Report states that additional testing and time to gather more information may be needed for the BARCT Refinery FCCU and CO Boiler rule. In fact, BAAQMD has adjusted the proposed implementation schedule to better account for the additional time needed. Shell appreciates BAAQMD recognition of the importance of thorough information gathering necessary to obtain accurate data on potential emission reductions and data on cost of controls to calculate the cost effectiveness of a proposed BARCT rule. 1-4

More specifically, the Project Scope for FCCU and CO Boilers notes the need for additional testing and study to properly characterize condensable PM emissions from the CO Boilers. Due to the flow patterns in Shell's CO Boiler stacks, BAAQMD staff agree that current EPA test methodologies are not able to accurately measure condensable particulate in these stacks. Shell agrees further testing and study is needed to properly characterize condensable particulate emissions.

Attainment for SO_2 and Non-attainment for PM

AB617 requires BARCT implementation in non-attainment areas. Although the Bay Area is in attainment for sulfur dioxide (SO_2), BAAQMD staff focuses on SO_2 emission reductions in the Project Scope for FCCU and CO Boilers because SO_2 emissions can lead to the formation of condensable PM. Shell believes instead that the cost effectiveness for this BARCT rule should be based on the emission reductions of the non-attainment pollutant (PM) rather than on the attainment pollutant (SO_2). However, 1-5 until the condensable PM emissions can be accurately measured from the CO Boiler stacks, the condensable PM reductions as a result of SO_2 reductions cannot be accurately determined for use in the cost effectiveness calculations. Therefore, until additional information on condensable PM from SO_2 can be obtained, it will be difficult to develop a BARCT rule. 1-5 cont.

New/Reconstructed/Modified versus Existing (BACT versus BARCT)

The Project Scope sets a preliminary SO_2 BARCT level of 50 parts per million by volume (ppmv) on a seven-day rolling average and 25 ppmv on a 365-day rolling average based on Best Available Control Technology (BACT) guidelines and New Source Performance Standards (NSPS) Subpart Ja for newly constructed, reconstructed and modified units. BAAQMD staff believes this will require the use of wet gas scrubbers (WGS). 1-6

By definition, BARCT is retrofit technology for an existing unit, which is not the same as new units or those being reconstructed or modified. Therefore, the BACT and NSPS Subpart Ja standards should not be used as a basis for BARCT.

WGS Cost Effectiveness

The current cost effectiveness estimates presented in the Project Scope severely underestimate the actual costs.

Capital Cost: BAAQMD estimates the costs for retrofitting an existing FCCU/CO Boiler with a WGS to be $135 million. The basis for this estimate is not detailed in the report. Shell believes the actual capital costs would be significantly greater. As explained below, Shell believes the cost will be over $700 million.

BAAQMD's own engineering evaluation in 2008 identified capital costs of up to $200 million for a WGS to be installed in Delaware (2008 Application#17798 for Tesoro, Plant No. 14628). Using this $200 million cost and adjusting to account for inflation, the 2018 capital costs would be $234 million. Even the $234 million value is a significant underestimate of actual costs to install a WGS at Shell. Examples of why the costs are understated are described below:

- The $234 million value is based on costs in Delaware but the cost to install a WGS in the Bay Area would be significantly higher due to the high construction cost in the Bay Area. 1-7

- As the engineering evaluation referenced above states, the capital cost estimates did not include costs associated with upgrades that would be needed for existing equipment. For example, Shell would need to replace the existing CO Boilers with new CO boilers that work at the higher pressures of the WGS system. New boilers could also trigger the installation of selective catalytic reduction (SCR) units for NOx control. The permitting, design and construction of new boilers would add significant costs.

- Due to the existing lack of free space at the Catalytic Cracking Unit and CO Boilers, the likelihood of identifying an area to accommodate the WGS and new CO Boilers footprint is highly unlikely. Given the limited space near the existing CO Boilers and if a feasible location can be found for the WGS, a significant amount of piping and infrastructure would be required to route the exhaust from the CCU to the new CO Boilers to the proposed WGS. Again, Shell strongly believes it is unlikely an area would be identified to accommodate the footprint of new CO Boilers and a WG.

- It is Shell's understanding that a recently built WGS project at Valero cost over $700 million, if not higher over 10 years ago.

Table 1 summaries the costs presented above. Considering the above factors, Shell believes the actual capital cost to install a WGS at the refinery would be at least $700 million. 1-7 cont.

Table 1. Summary of Capital Costs

Basis	BAAQMD Sept 2018 Project Scope	BAAQMD 2008 Tesoro Permit Evaluation Adjusted for Inflation	Shell Estimate[1]
Capital Cost	$135 Million	$234 Million	>700 Million

[1]With Site Specific Considerations and Valero Actual Costs

Operating Cost: In addition, the operating costs are significantly greater than what is used in the Project Scope. Based on factors presented in the Initial Staff report, the annual maintenance and operating cost used in the Project Scope appears to be about $9 million per year. This is in contrast to the $26 million per year operating cost based on the Tesoro engineering evaluation (after adjusting the listed $22 million per year for inflation). Operating and maintenance costs for WGS need to account for the additional energy and water usage; the more frequent maintenance required to address corrosion in the WGS; and additional cost of disposing liquid and solid waste, which may be hazardous (e.g., cost of laboratory analysis, handling and transportation, treatment, and final disposal). 1-8

Cost Effectiveness: Using the conservatively low 2018 capital costs of $234 million and the same annualized factors used in the 2008 engineering evaluation, the annualized capital cost would be $47 million per year. Adding this 2018 annualized capital cost and the 2018 operating cost of $26 million per year, the total annualized cost would be $73 million per year. Based on a potential reduction of 567 tons per year estimated by BAAQMD, the resulting cost effectiveness would then be $130,000 per ton.

Using the Shell Martinez estimate of at least $700 million, the annualized factors used in the 2008 engineering evaluation, and the same $26 million per year operating cost, the cost effectiveness would be at least $300,000 per ton. The Project Scope's estimate of $47,000 per ton significantly underestimates the cost-effectiveness of the WGS. Table 2 summaries the cost effectiveness results presented above.

Considering BAAQMD's low capital and operating cost estimates, Shell requests BAAQMD provide more details on the basis for BAAQMD's cost estimates. For example, what was BAAQMD's basis for the $135 million capital cost estimate? Also, the Initial Staff Report lists the factors to estimate annual cost from the capital cost. However, the General and Administrative cost factor (identified as typically being 2 percent of the capital cost in BAAQMD's BACT Policy and Implementation Procedure) was not listed and does not appear to be have been considered. 1-9

Table 2. Summary of Cost Effectiveness

Basis	BAAQMD Project Scope September 2018	BAAQMD 2008 Tesoro Permit Evaluation Adjusted for Inflation	Shell Estimate[1]
Cost Effectiveness	$47,000 per ton	$130,000 per ton	>$300,000 per ton

[1]With Site Specific Considerations and Valero Actual Costs

WGS – GHG, Energy, Water and other Environmental Impact Considerations

By requiring the installation of WGS on a FCCU, GHG emissions will increase as a result of the higher energy demand to operate a WGS. Thus, while the use of a WGS may result in a decrease in CCU criteria pollutants, facility wide GHG emissions and energy use will increase. In addition, there will be other environmental impacts from the construction and operation of a WGS. 1-10

In particular, the increased water use for a WGS must be carefully evaluated and considered. Also, the liquid purged from the WGS will need to be appropriately treated before discharging or reusing the liquid. This will result in the generation of additional waste water and solid waste (potentially hazardous waste) as well as potentially new wastewater treatment equipment. Also, the use of a WGS would likely result in a colder, saturated plume that would not disperse as effectively as exhaust going through the current CO Boiler stacks, thereby countering some of the benefits of reduced emissions to local receptors. These impacts must be considered when determining the overall benefit of the rule. 1-10 cont.

Catalyst Additives

In addition, the Project Scope notes that further study is needed to assess the use of a catalyst additive to reduce SO_2 emissions. Shell is not aware of any data the demonstrates Data is not currently proposed BARCT levels can be achieved through the use of catalyst additives. Shell agrees further study and testing is needed to properly assess the cost and benefits of using catalyst additive to reduce SO_2 emissions. 1-11

Summary

In summary, Shell has the following comments:

- **Additional PM Studies:** To develop an effective rule, additional studies are needed to accurately characterize any potential PM emission reductions.
- **Attainment:** Since the area is in attainment of SO_2 and non-attainment of PM standards, the cost-effectiveness should be based on PM emission reductions (which again cannot be accurately determined without further study).
- **Retrofit vs New/Modified:** The proposed SO_2 limits are based on BACT guidelines and NSPS, both of which are for newly constructed, reconstructed, and modified units. However, BARCT applies to the retrofit of existing units not being reconstructed or modified and so the proposed limits are not appropriate. 1-12
- **WGS Cost Effectiveness:** The actual costs for retrofitting an existing FCCU/CO Boiler with a WGS are significantly greater than estimated by BAAQMD.
- **Other Environmental Impacts:** WGS would result in higher energy consumption, greater GHG emissions, increase water usage, and greater liquid and solid waste generation.
- **Catalyst Additives:** Additional studies would be needed to determine the potential emission reductions and cost effectiveness of catalyst additives.

Shell is looking forward to continuing to work with BAAQMD staff to further discuss these concerns and determine a path forward.

Please contact Rick Shih at 925-313-0586 if you would like to discuss these issues in more detail.

Very truly yours,

Gordon Johnson
Manager, Environmental
Shell Oil Products, US – Martinez Refinery

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Comment Letter No. 1

Gordon Johnson
Shell Oil Products, U.S. – Martinez Refinery

Response No. 1-1

Comment 1-1 is an introductory comment indicating that the letter provides comments on the Expedited Best Available Retrofit Control Technology (BARCT) Draft Environmental Impact Report (DEIR) and Staff Report.

The comment indicates that the comments provided by Shell on October 5, 2018 for the Initial Staff Report are still applicable to the Staff Report. The comment does not address any issue related to the DEIR and no response is required.

Response No. 1-2

Response 1-2 summarizes the conclusions in the DEIR with respect to water demand impacts, which reported that water demand impacts were potentially significant.

The comment further indicates that generating up to 300 gallons per minute of new wastewater would require upgrades to Shell's existing wastewater infrastructure and revisions to Shell's NPDES permit, and suggests that the EIR include a more complete analysis of water quality impacts or conclude that water quality impacts are potentially significant. Shell's comment incorrectly implies that the volume of the wastewater stream from a wet gas scrubber (WGS) would equal the volume of the water feed to the scrubber. To the contrary, by the nature of the process, only a fraction of the water used by a WSG is discharged as wastewater. This is because a large portion of the water demand is lost in the abatement process and through steam. Water used in the WGS is emitted in the form of steam from a stack that is saturated with water, forming a steam plume. The steam plume is the result of using water to reduce the particulate emissions in the WGS. Therefore, the wastewater generation would not equal the entire 300 gpm of water demand. For example, one wet ESP and WGS were installed on the FCCU at the Phillips 66 Los Angeles Refinery, and the environmental analysis for the project indicated that the expected wastewater discharge from the combined operation would be about 70 gallons per minute (100,800 gallons per day) as opposed to the system water demand of 300 gpm.[1] The current permitted wastewater discharge flow from the Martinez Refinery is about 10 million gallons per day with an average flow of 5.9 million gallons per day.[2] Therefore, the installation of a WGS would result in an increase in wastewater of about one percent of the maximum wastewater treatment capacity at the Shell Refinery (1.7 percent of the average flow), thus representing a relatively small increase in wastewater discharge from the Refinery.

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[1] SCAQMD, 2007. Final EIR for the ConocoPhillips Los Angeles Refinery PM10 and NOx Reduction Projects, SCH No. 2006111138. Available at: http://www.aqmd.gov/home/research/documents-reports/lead-agency-permit-projects/permit-project-documents---year-2007/feir-for-conocophillips-pm10-and-nox-reduction

[2] San Francisco Bay Regional Water Quality Control Board, Tentative Order No. R2-2017-00XX, NPDES No. CA0005789. Available at: https://pubapps.waterboards.ca.gov/sanfranciscobay/board_info/agendas/2017/October/shelloil/Tentative_Order.pdf

The potential increase in wastewater generation may require that facilities modify their National Pollution Prevention Discharge Elimination System (NPDES) permit, which varies from facility to facility. However, all facilities that would be affected by the expedited BARCT requirements operate under the requirements of an NDPES permit. As discussed in the DEIR (see Page 3.4-9), the NPDES permit establishes discharge pollutant thresholds and operational conditions for industrial facilities (including refineries) and wastewater treatment plants. For point sources (including refineries), the Regional Water Quality Control Boards prepare specific effluent limitations for constituents of concern and require monitoring of those constituents. Constituents of concern for the Shell Refinery include biochemical oxygen demand (BOD), total suspended solids, chemical oxygen demand (COD), oil and grease, total sulfides, phenolic compounds, chromium and hexavalent chromium, ammonia nitrogen, copper, cyanide, nickel, selenium, dioxin, and pH. By operating under the NPDES requirements, along with the enforcement of the permit as well as other existing regulations, the impacts on water quality associated with the installation of a WGS are expected to be less than significant.

Response No. 1-3 to 1-12

As stated in Response No. 1-1, Comment 1-1 indicates that the comments provided by Shell on October 5, 2018 for the Initial Staff Report are still applicable to the Staff Report. Comments 1-3 through 1-12 pertain to the Staff Report, and the comments do not address the DEIR and no response is required.

4.0 CHANGES TO THE DRAFT EIR

This section includes changes made to the DEIR due to recommended clarifications and other revisions. None of the modifications alter any conclusions reached in the Draft EIR, nor provide new information of substantial importance relative to the draft document that would require recirculation of the Draft EIR pursuant to CEQA Guidelines §15088.5. Additions to the text of the Final EIR are denoted using underline. Text that has been eliminated is shown using ~~strike outs~~.

3.2.4.2 Potential Criteria Pollutant Impacts During Operation

Table 3.2-29 has been revised and incorporated into the Final EIR to reflect corrections in the number of truck trips and corrections to transcription errors from the Draft EIR Appendix B. The table listed the number of one-way truck trips while the trip length reflected a round trip distance, resulting in the peak daily estimated emissions to be doubled. This has been changed by correcting the number of truck trips to reflect round trips rather than one-way trips for the peak-daily emissions calculations. Revisions are also being made to correct clerical errors that were made when transcribing the ROG, CO, PM_{10}, and $PM_{2.5}$ emissions from the Draft EIR Appendix B to the summary tables. None of these modifications alter any conclusions reached in the Draft EIR, nor provide new information of substantial importance relative to the draft document that would require recirculation of the Draft EIR pursuant to CEQA Guidelines §15088.5.

TABLE 3.2-29

Delivery Truck Emissions

Material	Truck Trips	Estimated Trip Length (mi)	Criteria Pollutant					
			ROG **~~CO~~**	**CO** **~~ROG~~**	**NOx**	**SOx**	**PM_{10}**	**$PM_{2.5}$**
Operational Emissions Per Facility (lbs/day)								
Caustic/Catalyst for 3 WGS Units	3 ~~6~~	120	0.13 ~~0.24~~	0.83 ~~1.65~~	3.88 ~~7.77~~	0.01 ~~0.03~~	0.93 ~~0.18~~	0.24 ~~0.06~~
Caustic/Catalyst for LoTox Scrubber	1 ~~2~~	120	0.04 ~~0.08~~	0.28 ~~0.55~~	1.29 ~~2.59~~	<0.01 ~~0.01~~	0.31 ~~0.06~~	0.08 ~~0.02~~
Lime for Cement Kiln	1 ~~2~~	100	0.04 ~~0.07~~	0.23 ~~0.46~~	1.08 ~~2.16~~	<0.01 ~~0.01~~	0.26 ~~0.05~~	0.07 ~~0.01~~
Total Peak Daily Emissions			**0.20** **~~0.39~~**	**1.34** **~~2.66~~**	**6.25** **~~12.52~~**	**0.02** **~~0.05~~**	**1.50** **~~0.29~~**	**0.38** **~~0.09~~**
Operational Emissions Per Facility (Tons/year)								
Caustic/Catalyst for 3 WGS	312	120	0.01 ~~0.03~~	0.04 ~~0.03~~	0.20 ~~0.21~~	<0.01 ~~0.03~~	0.05 ~~0.06~~	0.01 ~~0.03~~
Caustic/Catalyst for LoTox Scrubber	104	120	<0.01	0.01	0.07	<0.01	0.02	<0.01

Lime for Cement Kiln	365	100	0.01	0.04	0.20	<0.01	0.05	0.01
Total Annual Transport Emissions			**0.02** ~~**0.05**~~	**0.10** ~~**0.08**~~	**0.47** ~~**0.48**~~	**<0.01** ~~**0.05**~~	**0.11** ~~**0.13**~~	**0.03** ~~**0.05**~~

Table 3.2-30 has been revised accordingly to reflect the revisions to the total emissions in Table 3.2-29. Additionally, a rounding error has been corrected under Annual Concurrent Operational Emissions for oxidizers, changing the total emissions from 19.5 tons/yr to 19.4 tons/yr. None of these modifications alter any conclusions reached in the Draft EIR, nor provide new information of substantial importance relative to the draft document that would require recirculation of the Draft EIR pursuant to CEQA Guidelines §15088.5.

TABLE 3.2-30

Worst-Case Operational Emissions Under the AB 617 Expedited BARCT Implementation Schedule

ACTIVITY	ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$
Daily Concurrent Operational Emissions (lb/day)						
15 Oxidizers	2.4	107	13.1	0.2	2.6	2.6
Delivery Trucks for Caustic, Ammonia, and Lime	0.2 ~~2.7~~	1.3 ~~0.4~~	6.3 ~~12.5~~	<0.1 ~~0.1~~	1.5 ~~0.3~~	0.4 ~~0.1~~
Total Concurrent Emissions	2.6 ~~5.1~~	107.9 ~~107.4~~	19.4 ~~25.6~~	0.2 ~~0.3~~	4.1 ~~2.9~~	3.0 ~~2.7~~
Reductions from Project Implementation(1)	411	--	--	6,932	--	--
Net Concurrent Emissions(2)	-408.4 ~~-405.9~~	107.9 ~~107.4~~	19.4 ~~25.6~~	-6931.3 ~~-6,931.8~~	4.1 ~~2.9~~	3.0 ~~2.7~~
Significance Thresholds	**54**	**None**	**54**	**None**	**82**	**54**
Significant?	**No**	**--**	**No**	**--**	**No**	**No**
Annual Concurrent Operational Emissions (tons/yr)						
15 Oxidizers	0.4	19.4 ~~19.5~~	2.4	<0.1	0.5	0.5
Delivery Trucks for Caustic, Ammonia, and Lime	≤0.1	0.1	0.5	≤0.1	0.1	≤0.1
Total Concurrent Emissions	0.5	19.5	2.9	0.1	0.6	0.5
Reductions from Project Implementation	75.0	--	--	1,265.0	--	--
Net Concurrent Emissions(2)	-74.5	19.5	2.9	-1,264.9	0.6	0.5
Significance Thresholds	**10**	**None**	**10**	**None**	**15**	**10**
Significant?	**No**	**--**	**No**	**--**	**No**	**No**

(1) See Table 3.2-10. Assumes 365 days of operations.
(2) Negative numbers indicate emission benefit.

Appendix B:

Appendix B has been revised to reflect the changes in Tables 3.2-29 and 3.2-30. The tables on page B-16 have been revised to better clarify the truck trip emission calculations. The summary table on page B-2 has been revised to reflect the changes in Tables 3.2-30. None of these modifications alter any conclusions reached in the Draft EIR, nor provide new information of substantial importance relative to the draft document that would require recirculation of the Draft EIR pursuant to CEQA Guidelines §15088.5.

Appendix B
Expedited BARCT Implementation Schedule
Operational Delivery Truck Emissions

Equipment	Vehicle	Trip Length	Total Trips	VMT	VOC (lb/mi)	CO (lb/mi)	NOx (lb/mi)	SOx (lb/mi)	PM (lb/mi)	Fugitive PM	CO2e (lb/mile)	VOC (lbs)	CO (lbs)	NOx (lbs)	SOx (lbs)	PM10 (lbs)	PM2.5 (lbs)	CO2e (MT)
Caustic/Catalyst for 1 WGS	HHDT	120	104	12480	0.00035	0.00231	0.01078	0.00004	0.00027	0.00231	3.745	4.397	28.805	134.496	0.437	32.213	8.241	21.202
Caustic/Catalyst for 1 LoTox Scrubber	HHDT	120	104	12480	0.00035	0.00231	0.01078	0.00004	0.00027	0.00231	3.745	4.397	28.805	134.496	0.437	32.213	8.241	21.202
Lime for Cement Kiln	HHDT	100	365	36500	0.00035	0.00231	0.01078	0.00004	0.00027	0.00231	3.745	12.860	84.246	393.357	1.279	94.212	24.101	62.008
Annual Emissions (tons/yr)												**0.05**	**0.08**	**0.48**	**0.05**	**0.13**	**0.05**	**146.82**
Peak Daily (lb/day)												**0.39**	**2.66**	**12.52**	**0.05**	**0.29**	**0.09**	**0.58**

Notes:

(1) Peak day assumes 3 caustic delivery trucks for WGS, 1 caustic delivery truck for LoTOx, and 1 lime delivery truck.

(2) Emfac2014 emission factors for the San Francisco Bay Area District for 2019 fleet.

(3) Fugitive PM emission calculations for travel on paved roads from EPA AP-42 Section 13.2.1, January 2011

$E = k(sL)^{0.91} \times (W)^{1.02}$

Where: k = 0.0022 lb/VMT for PM 10, sL = road silt loading (gms/m2)

(0.03 for major/collector roads), W = weight of vehicles (2.5 tons for light, 5.5 for medium trucks,

and 24 for heavy trucks)

(4) Carbon Dioxide Equivalence (CO_E) = $CO_2 + CH_4 * 21 + N2O*310$

where CO2 emissions factors are from Emfac2011. CH4 and N2O emissions factors are from Direct Emissions from Mobile Combustion Sources, EPA 2008.

where light vehicle are gasoline light duty trucks.

where medium/heavy duty vehicle are diesel heavy duty trucks.

	2019		
Chemical	Light	Medium	Heavy
CO2 (lb/mi)	0.8949	2.2430	3.7418
CH4 (g/mi)	0.0148	0.0051	0.0051
N2O (g/mi)	0.0157	0.0048	0.0048
CO2e (lb/mi)	0.906	2.247	3.745

Daily Peak Emissions (lbs/day)	VOC (lbs)	CO (lbs)	NOx (lbs)	SOx (lbs)	PM10 (lbs)	PM2.5 (lbs)	CO2e (MT)
Caustic/Catalyst for 1 WGS	0.08	0.55	2.59	0.01	0.06	0.02	898.86
Caustic/Catalyst for 1 LoTox Scrubber	0.08	0.55	2.59	0.01	0.06	0.02	898.86
Lime for Cement Kiln	0.07	0.46	2.10	0.01	0.05	0.01	749.05

Annual Emissions (tons/yr)	VOC (lbs)	CO (lbs)	NOx (lbs)	SOx (lbs)	PM10 (lbs)	PM2.5 (lbs)	CO2e (MT)
Caustic/Catalyst for 1 WGS	0.00	0.01	0.07	0.00	0.02	0.00	0.01
Caustic/Catalyst for 1 LoTox Scrubber	0.00	0.01	0.07	0.00	0.02	0.00	0.01
Lime for Cement Kiln	0.01	0.04	0.20	0.00	0.05	0.01	0.03

Appendix B
Expedited BARCT Implementation Schedule
Operational Emissions Summary

ACTIVITY	ROG	CO	NOx	SOx	PM10	PM2.5	CO2e (MT)
Daily Concurrent Operational Emissions (lb/day)							
15 Oxidizers	2.4	107	13.1	0.2	2.6	2.6	18.7
Electricity for WGS, LoTox, SCR, and ESP	--	--	--	--	--	--	1.2
Delivery Trucks for Caustic, Ammonia, and Lime	2.7	0.4	12.5	0.1	0.3	0.1	0.7
Total Concurrent Emissions	5.1	107.4	25.6	0.3	2.9	2.7	20.6
Reductions from Project Implementation(1)	411.0	--	--	6932	--	--	--
Net Concurrent Emissions(2)	-405.9	107.4	25.6	-6931.8	2.9	2.7	20.6
Significance Thresholds	54	None	54	None	82	54	None
Significant?	No	--	No	--	No	No	--
Annual Concurrent Operational Emissions (tons/yr)							
15 Oxidizers	0.4	19.5	2.4	0.1	0.5	0.5	6825.7
Electricity for WGS, LoTox, SCR, and ESP	--	--	--	--	--	--	451.9
Delivery Trucks for Caustic, Ammonia, and Lime	0.1	0.1	0.5	0.1	0.1	0.1	111.2
Total Concurrent Emissions	0.5	19.5	2.9	0.1	0.6	0.5	7388.8
Reductions from Project Implementation	75.0	0.0	0.0	1265.0	0.0	0.0	0.0
Net Concurrent Emissions(2)	-74.5	19.5	2.9	-1264.9	0.6	0.5	7388.8
Significance Thresholds	10	None	10	None	15	10	10000
Significant?	No	--	No	--	No	No	No

Note:

(1) Assumes 365 days of operations.

(2) Negative numbers indicate emission benefit.

Appendix B
Expedited BARCT Implementation Schedule
Operational Delivery Truck Emissions

Equipment	Vehicle	Trip Length	Total Trips	VMT	VOC (lb/mi)	CO (lb/mi)	NOx (lb/mi)	SOx (lb/mi)	PM (lb/mi)	Fugitive PM	CO2e (lb/mile)	VOC (lbs)	CO (lbs)	NOx (lbs)	SOx (lbs)	PM10 (lbs)	PM2.5 (lbs)	CO2e (MT)
Caustic/Catalyst for 3 WGS	HHDT	120	312	37440	0.00035	0.00231	0.01078	0.00004	0.00027	0.00231	3.745	13.191	86.415	403.487	1.311	96.639	24.722	63.605
Caustic/Catalyst for LoTox Scrubber	HHDT	120	104	12480	0.00035	0.00231	0.01078	0.00004	0.00027	0.00231	3.745	4.397	28.805	134.496	0.437	32.213	8.241	21.202
Lime for Cement Kiln	HHDT	100	365	36500	0.00035	0.00231	0.01078	0.00004	0.00027	0.00231	3.745	12.860	84.246	393.357	1.279	94.212	24.101	62.008
Annual Emissions (tons/yr)												**0.02**	**0.10**	**0.47**	**0.00**	**0.11**	**0.03**	**146.81**
Peak Daily (lb/day)												**0.20**	**1.34**	**6.25**	**0.02**	**1.50**	**0.38**	**0.99**

Notes:

(1) Peak day assumes 3 caustic, 1 ammonia, and 1 lime delivery truck

(2) Emfac2014 emission factors for the San Francisco Bay Area District for 2019 fleet

(3) Fugitive PM emission calculations for travel on paved roads from EPA AP-42 Section 13.2.1, January 2011

$E = k(sL)^{0.91} \times (W)^{1.02}$

Where: k = 0.0022 lb/VMT for PM10, sL = road silt loading (gms/m2)

(0.03 for major/collector roads), W = weight of vehicles (2.5 tons for light, 5.5 for medium trucks

and 24 for heavy trucks)

(4) Carbon Dioxide Equivalence (CO_2e) = CO_2 + CH_4*21 + N2O*310

where CO2 emissions factors are from Emfac2011. CH4 and N2O emissions factors are from Direct Emissions from Mobile Combustion Sources, EPA 2008

where light vehicle are gasoline light duty trucks

where medium/heavy duty vehicle are diesel heavy duty trucks

Chemical	2019		
	Light	Medium	Heavy
CO2 (lb/mi)	0.8949	7.2430	3.7419
CH4 (g/mi)	0.0148	0.0051	0.0051
N2O (g/mi)	0.0167	0.0048	0.0049
CO2e (lb/mi)	0.906	7.247	3.745

Single Trip Emissions (lbs/day)	VOC	CO	NOx	SOx	PM10	PM2.5	CO2e (MT)
Caustic/Catalyst for 3 WGS	0.13	0.83	3.88	0.01	0.93	0.24	0.61
Caustic/Catalyst for LoTox Scrubber	0.04	0.28	1.29	0.00	0.31	0.08	0.20
Lime for Cement Kiln	0.04	0.23	1.08	0.00	0.26	0.07	0.17
Total Peak Daily Emissions	0.20	1.34	6.25	0.02	1.50	0.38	0.99

Total Annual Emissions (tons/yr)	VOC	CO	NOx	SOx	PM10	PM2.5	CO2e (MT)
Caustic/Catalyst for 3 WGS	0.01	0.04	0.20	0.00	0.05	0.01	63.60
Caustic/Catalyst for LoTox Scrubber	0.00	0.01	0.07	0.00	0.02	0.00	21.20
Lime for Cement Kiln	0.01	0.04	0.20	0.00	0.05	0.01	62.01
Total Annual Emissions	0.02	0.10	0.47	0.00	0.11	0.03	146.81

Appendix B
Expedited BARCT Implementation Schedule
Operational Emissions Summary

ACTIVITY	ROG	CO	NOx	SOx	PM10	PM2.5	CO2e (MT)
Daily Concurrent Operational Emissions (lb/day)							
15 Oxidizers	2.4	106.6	13.1	0.2	2.6	2.6	18.7
Electricity for WGS, LoTox, SCR, and ESP	--	--	--	--	--	--	1.2
Delivery Trucks for Caustic, Ammonia, and Lime	0.2	1.3	6.3	0.0	1.5	0.4	1.0
Total Concurrent Emissions	2.6	107.9	19.4	0.2	4.1	3.0	20.9
Reductions from Project Implementation(1)	411.0	--	--	6931.5	--	--	--
Net Concurrent Emissions(2)	-408.4	107.9	19.4	-6931.3	4.1	3.0	20.9
Significance Thresholds	54	None	54	None	82	54	None
Significant?	No	--	No	--	No	No	--
Annual Concurrent Operational Emissions (tons/yr)							
15 Oxidizers	0.4	19.4	2.4	0.0	0.5	0.5	6825.7
Electricity for WGS, LoTox, SCR, and ESP	--	--	--	--	--	--	451.9
Delivery Trucks for Caustic, Ammonia, and Lime	0.0	0.1	0.5	0.0	0.1	0.0	146.8
Total Concurrent Emissions	0.5	19.5	2.9	0.0	0.6	0.5	7424.4
Reductions from Project Implementation	75.0	0.0	0.0	1265.0	0.0	0.0	0.0
Net Concurrent Emissions(2)	-74.5	19.5	2.9	-1265.0	0.6	0.5	7424.4
Significance Thresholds	10	None	10	None	15	10	10000
Significant?	No	--	No	--	No	No	No

Note:

(1) Assumes 365 days of operations.

(2) Negative numbers indicate emission benefit.

Notice of Public Hearing
and California Environmental Quality Act
Notice of Availability of a Draft Environmental Impact Report
for
AB 617 Expedited Best Available Retrofit Control Technology Implementation Schedule

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TO: **Interested Parties**

FROM: **Bay Area Air Quality Management District**
375 Beale St., Suite 600
San Francisco, CA 94105

Lead Agency: **Bay Area Air Quality Management District**
Contact: **David Joe, Principal Air Quality Engineer Phone: (415) 749-8623**

SUBJECT: NOTICE OF PUBLIC HEARING AND CEQA NOTICE OF AVAILABILITY OF A DRAFT ENVIRONMENTAL IMPACT REPORT

Notice is hereby given pursuant to California Public Resource Code, Sections 15206 and 15087 (c) that the Bay Area Air Quality Management District ("Air District") has prepared a Draft Environmental Impact Report (EIR) for the Assembly Bill 617 (AB 617) Expedited Best Available Retrofit Control Technology (BARCT) Implementation Schedule in accordance with California Environmental Quality Act (CEQA) requirements. Notice is also given that the Board of Directors of the Bay Area Air Quality Management District will conduct a public hearing on December 19, 2018, at the Air District Headquarters' Board Room, 375 Beale Street, San Francisco, California, at 9:45 a.m., or as soon thereafter as the matter may be heard, to consider adoption of the AB 617 Expedited BARCT Implementation Schedule and certification of a final Environmental Impact Report.

Project Title: Assembly Bill 617 Expedited Best Available Retrofit Control Technology (BARCT) Implementation Schedule

State Clearinghouse Number: 2018082003

Project Location: The proposed Expedited BARCT Implementation Schedule applies within the Bay Area Air Quality Management District ("District"), which includes all of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, and Santa Clara counties, and the southern portions of Solano and Sonoma counties.

Project Description: Assembly Bill 617, approved July 26, 2017, amends California Health and Safety Code section 40920.6 et seq. and requires each air district that is a nonattainment area for one or more air pollutants to adopt an expedited schedule for implementation of best available retrofit control technology (BARCT) on specified facilities by the earliest feasible date, but no later than December 31, 2023. Local air districts are required to adopt this schedule before January 1, 2019. This requirement applies to each industrial source subject to California Greenhouse Gas (GHG) Cap-and-Trade requirements. The overall purpose of BARCT implementation is to reduce criteria pollutant emissions from significant industrial sources that currently participate in the GHG Cap-and-Trade system.
The Expedited BARCT Implementation Schedule includes six potential rule development projects to address emissions from: 1) organic liquid storage tanks; 2) petroleum wastewater treating; 3) Portland cement manufacturing; 4) refinery fluid catalytic crackers and CO gas boilers; 5) refinery heavy liquid leaks; and 6) petroleum coke calcining.

Significant Impacts: The draft EIR for the Expedited BARCT Implementation Schedule concluded that air quality impacts associated with the construction of air pollution control equipment would be potentially significant after mitigation and cumulatively considerable. Water demand impacts from the operation of air pollution control equipment were found to be potentially significant after mitigation and cumulatively considerable. Mitigation measures are required for air quality impacts from construction activities and water demand impacts from operation of air pollution control equipment.

The proposed AB 617 Expedited BARCT Implementation Schedule staff report and draft EIR are available at the Air District headquarters, on the website at http://www.baaqmd.gov/ab617barct, or by request. Requests for copies of the staff report or draft EIR should be directed to Karen Fremming (kfremming@baaqmd.gov) at (415) 749-8427.

Comments relating to the proposed schedule and environmental analysis should be addressed to David Joe, Bay Area Air Quality Management District, 375 Beale Street, Suite 600, San Francisco, CA 94105. Comments may also be sent by e-mail to djoe@baaqmd.gov. Comments on the proposed Expedited BARCT Implementation Schedule and draft EIR will be accepted from October 23, 2018 until December 7, 2018 at 5:00 p.m.

Jack P. Broadbent
Executive Officer
Bay Area Air Quality Management District

Draft Environmental Impact Report for the Bay Area Air Quality Management District

AB 617 Expedited BARCT Implementation Schedule Project

Prepared for:

Bay Area Air Quality Management District
375 Beale St., Suite 600
San Francisco, CA 94109
Contact: David Joe
(415) 749-8623

Prepared By:

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October 2018

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PREFACE

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CHAPTER 1

INTRODUCTION AND EXECUTIVE SUMMARY

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1.0 INTRODUCTION AND EXECUTIVE SUMMARY

1.1 INTRODUCTION

The Bay Area Air Quality Management District (District), in accordance with Assembly Bill 617, (AB 617) is proposing to implement the Expedited Best Available Retrofit Control Technology (BARCT) Implementation Schedule (project or proposed project). AB 617 requires each air district that is a nonattainment area for one or more air pollutants to adopt an expedited schedule for implementation of BARCT by the earliest feasible date but no later than 2023. This requirement applies to industrial sources subject to California's Greenhouse Gas (GHG) Cap-and-Trade requirements.

The purpose of the proposed project is to reduce criteria pollutant emissions from industrial sources that currently participate in the GHG Cap-and-Trade system. The Cap-and-Trade system is designed to address and limit GHG emissions, and allows sources to comply with Cap-and-Trade limits by either reducing emissions at the source or purchasing GHG emission allowances. Emissions of criteria pollutants and toxic air contaminants are often associated with GHG emissions, and these criteria pollutants and toxic air contaminants may impact local communities that are already suffering a disproportionate burden from air pollution. The goal of AB 617 is to reduce communities' burden from air pollution and the Expedited BARCT Implementation Schedule is part of that process.

1.2 CALIFORNIA ENVIRONMENTAL QUALITY ACT

The California Environmental Quality Act (CEQA), Public Resources Code Section 21000 et seq., requires that the potential environmental impacts of proposed projects be evaluated and that feasible methods to reduce or avoid identified significant adverse environmental impacts of these projects be identified. To fulfill the purpose and intent of CEQA, the Air District has prepared this Environmental Impact Report (EIR) under the requirements of CEQA Guidelines §15187 to address the potential environmental impacts associated with the Expedited BARCT Implementation Schedule. Prior to making a decision on the adoption of the proposed project, the Air District Governing Board must review and certify the EIR as providing adequate information on the potential adverse environmental impacts of implementing the proposed Expedited BARCT Implementation Schedule.

1.2.1 NOTICE OF PREPARATION/INITIAL STUDY

A Notice of Preparation for the Draft EIR for the Expedited BARCT Implementation Schedule was distributed to responsible agencies and interested parties for a 30-day review on August 7, 2018. A notice of the availability of this document was distributed to other agencies and organizations and was placed on the Air District's web site. A public scoping meeting was held at the District headquarters on August 24, 2018. Two public comment letters were submitted on the NOP to the Air District and are included in Appendix A of this EIR.

The NOP/IS identified impacts on the following environmental resources as being potentially significant, requiring further analysis in the EIR: air quality, hazards and hazardous materials, hydrology and water quality, and utilities and service systems. Impacts on the following environmental resources were considered to be less than significant in the NOP/IS: aesthetics, agriculture and forestry resources, biological resources, cultural resources, geology/soils, greenhouse gas emissions, land use/planning, mineral resources, noise, population/housing, public services, recreation, transportation/traffic, and tribal cultural resources (see Appendix A). Water demand impacts were considered to be potentially significant in both the hydrology and water quality section, and the utilities and service systems portion of the Initial Study. In the EIR, the discussion of water demand impacts was consolidated into the hydrology and water quality section.

1.2.2 TYPE OF EIR

In accordance with §15121(a) of the State CEQA Guidelines (California Administrative Code, Title 14, Division 6, Chapter 3), the purpose of an EIR is to serve as an informational document that: "will inform public agency decision-makers and the public generally of the significant environmental effect of a project, identify possible ways to minimize the significant effects, and describe reasonable alternatives to the project." The EIR is an informational document for use by decision-makers, public agencies and the general public. The proposed project requires discretionary approval and, therefore, it is subject to the requirements of CEQA (Public Resources Code, §21000 et seq.).

The focus of this EIR is to address the environmental impacts of the implementation of the Expedited BARCT Implementation Schedule as identified in the NOP and Initial Study (included as Appendix A of this EIR). The degree of specificity required in an EIR corresponds to the degree of specificity involved in the underlying activity described in the EIR (CEQA Guidelines §15146). The Expedited BARCT Implementation Schedule would apply to industrial sources including petroleum refineries, facilities with storage tanks, cement kilns, and petroleum coke calciners.

1.2.3 INTENDED USES OF THIS DOCUMENT

In general, a CEQA document is an informational document that informs a public agency's decision-makers, and the public generally, of potentially significant adverse environmental effects of a project, identifies possible ways to avoid or minimize the significant effects, and describes reasonable alternatives to the project (CEQA Guidelines §15121). A public agency's decision-makers must consider the information in a CEQA document prior to making a decision on the project. Accordingly, this EIR is intended to: (a) provide the Air District's Board of Directors and the public with information on the environmental effects of the proposed project; and, (b) be used as a tool by the Air District's Board to facilitate decision making on the proposed project.

Additionally, CEQA Guidelines §15124(d)(1) requires a public agency to identify the following specific types of intended uses of a CEQA document:

1. A list of the agencies that are expected to use the EIR in their decision-making;

2. A list of permits and other approvals required to implement the project; and

3. A list of related environmental review and consultation requirements required by federal, state, or local laws, regulations, or policies.

There are no federal, state, or local permits required to adopt the Expedited BARCT Implementation Schedule. Local public agencies, such as cities, and counties could be expected to utilize this EIR if local approval is required for facility modifications due to the implementation of BARCT (e.g., new air pollution control equipment) at affected industrial sources, pursuant to CEQA Guidelines §15152. However, implementation of the proposed project is limited to implementation of air pollution control equipment and measures.

1.2.4 AREAS OF POTENTIAL CONTROVERSY

In accordance with CEQA Guidelines §15123(b)(2), the areas of controversy known to the lead agency including issues raised by agencies and the public shall be identified in the EIR. As noted above, two comment letters were received on the NOP/IS. Issues and concerns raised in the comment letters included: (1) potential impacts associated with the installation of geodesic domes on storage tanks; and (2) a recommendation that lead agencies consult with all California Native American tribes. The impacts on aesthetics associated with domes on storage tanks were addressed in the NOP/IS (see Appendix A). The NOP/IS concluded that BARCT measures would include the installation of equipment, including domes, that may be visible outside of the existing industrial facilities; however, these facilities are located in industrial areas which do not have scenic views or scenic resources. Storage tanks are generally located at refineries, bulk handling and storage facilities, or manufacturing facilities that are located in industrial areas. Because of the location, domes on storage tanks are not expected to have significant adverse aesthetic impacts to the surrounding communities. Regarding tribal resources, construction activities are limited to industrial facilities and all construction activities would take place at existing facilities that have been previously graded, such that proposed BARCT requirements are not expected to affect tribal resources. Nonetheless, individual projects will need to be examined on a project-specific basis, when the precise location and compliance methods are known, and additional consultation with tribes may be required.

1.3 EXECUTIVE SUMMARY: CHAPTER 2 – PROJECT DESCRIPTION

The Expedited BARCT Implementation Schedule strategy will consist of the implementation of several rule development projects in order to fulfill the requirements of AB 617. The Bay Area air basin is in attainment with both the National Ambient Air Quality Standards and California Ambient Air Quality Standards for carbon monoxide (CO), SO_2, NO_2, and lead. The air basin is designated as nonattainment for ozone (O_3) and particulate matter ($PM_{2.5}$ and PM_{10}) California ambient air standards, therefore the BARCT review was conducted focusing on the following pollutants:

- Nitrogen Oxides (NOx)
- Reactive Organic Gases (ROG)
- Particulate Matter less than 10 microns (PM_{10})

- Particulate Matter less than 2.5 microns ($PM_{2.5}$)
- Sulfur Dioxide (SO_2)

NOx and ROG are included because they are precursors for ozone formation. SO_2 may contribute to formation of condensable PM (i.e. formed in the emissions plume from the stack), so PM control strategies may include SO_2 limits.

A list of facilities, sources, and emissions were developed from the 2016 Reporting Year Emissions Inventory. The Bay Area has 80 facilities subject to Cap-and-Trade, which encompass 3,246 individual sources in 61 source categories. This list of facilities was reduced to 19 “industrial” facilities, which includes all covered entities that are eligible for free allowance allocations in accordance with the Cap-and-Trade requirements based on their engagement in an activity within a particular North American Industrial Code System (NAICS) Code listed in Table 8-1 of the Cap-and-Trade regulation (17 CCR § 95890(a)). These 19 industrial Cap-and-Trade facilities encompass 1,899 individual sources in 50 source categories. These sources were reviewed for the amount of emissions and existing controls that may already comply with BARCT. After screening for these sources with emissions greater than 10 pounds per day and sources that have not already achieved BARCT, the population of sources was reduced to the following:

- NOx: 21 source categories, 73 sources representing 30% of the emissions (1,764 tpy)
- ROG: 23 source categories, 259 sources representing 93% of the emissions (2,430 tpy)
- PM: 16 source categories, 124 sources representing 92% of the emissions (1,851 tpy)
- SO_2: 15 source categories, 102 sources representing 71% of the emissions (3,651 tpy)

The BAAQMD reviewed available information on current achievable emission limits and potential controls for each source category and pollutant. Six potential rule development projects have been identified for inclusion in the Expedited BARCT Implementation Schedule to address the following:

- Reduce ROG emissions from Organic Liquid Storage Tanks;
- Reduce ROG emissions associated with Refinery Wastewater Treatment Systems;
- Reduce PM and SO_2 emissions from Portland cement manufacturing;
- Reduce PM and SO_2 emissions from Refinery Fluid Catalytic Cracking Units and CO Gas Boilers;
- Reduce ROG emissions from Fugitive Heavy Liquid Leaks; and
- Reduce NOx emissions from Petroleum Coke Calcining Operations.

1.3.1 PROJECT OBJECTIVES

The objectives of the Expedited BARCT Implementation Schedule are to:

- Implement and/or install best available retrofit control technologies on industrial sources subject to CARB’s Cap-and-Trade program, as defined by the AB 617 requirements;

- Reduce criteria pollutant emissions from significant industrial sources that participate in CARB's Cap-and-Trade program;

- Lessen the burden of air quality impacts on communities that suffer a disproportionate burden from air pollution; and

- Comply with the requirements AB 617.

1.3.2 SOURCES AFFECTED BY EXPEDITED BARCT IMPLEMENTATION

The overall purpose of the Expedited BARCT Implementation Schedule is to reduce criteria pollutant emissions from significant sources that currently participate in CARB's GHG Cap-And-Trade program. Emissions of criteria pollutants and toxic air contaminants are often associated with GHG emissions, and these criteria pollutants and toxic air contaminants may impact local communities. The proposed project would apply to refineries, petroleum coke calcining facilities, and cement kilns.

1.3.3 BARCT EMISSION CONTROL TECHNOLOGIES

To comply with the BARCT requirements for affected facilities, operators could reduce operations or implement BARCT, which includes different types of air pollution control equipment or measures. The type of emission capture and control technology that may be used depends on the specific type of pollutant to be controlled. The air pollution control measures that are likely to be encountered as a result of the proposed BARCT requirements are categorized into the following groups:

- Installing domes on external floating roof tanks and capturing vented emissions from internal floating roof tanks or coned roof tanks and removing ROG emissions through a vapor recovery unit;
- Covering lift stations, manholes, junction boxes, conveyances and other wastewater facilities at refineries and venting ROG emissions to a vapor combustor;
- Requiring additional lime injection on cement kilns to control SO_2 in order to reduce condensable PM emissions;
- Controlling PM emissions from FCCUs using SO_2 reducing catalyst additives, additional ESP capacity, or wet gas scrubbers;
- Reducing ROG emissions from fugitive components in heavy liquid service at refineries through increased LDAR programs;
- Reducing NOx emissions from coke calcining facilities through the use of SCR units and/or LoTOx system with a wet scrubber.

1.4 EXECUTIVE SUMMARY: CHAPTER 3 – ENVIRONMENTAL SETTING, IMPACTS AND MITIGATION MEASURES

Chapter 3 of the Draft EIR describes the existing environmental setting in the Bay Area, analyzes the potential environmental impacts of the Expedited BARCT Implementation Schedule and recommends mitigation measures (when significant environmental impacts have been identified). Chapter 3 provides this analysis for each of the environmental areas identified in the Initial Study (see Appendix A), including: (1) Air Quality; (2) Hazards and Hazardous Materials; (3) Hydrology and Water Quality, and (4) Utilities and Service Systems. Included for each impact category is a discussion of the environmental setting, significance criteria, whether the proposed project will result in any significant impacts (either individually or cumulatively in conjunction with other projects), and feasible project-specific mitigation (if necessary and available). Note that water demand impact was found to be potentially significant under both Hydrology and Water Quality, and Utilities and Service Systems in the NOP/IS. In the EIR, the discussion of water demand impacts has been consolidated into the Hydrology and Water Quality resource section.

1.4.1 AIR QUALITY

1.4.1.1 Air Quality Setting

It is the responsibility of the Air District to ensure that state and federal ambient air quality standards (AAQS) are achieved and maintained in its geographical jurisdiction. Health-based air quality standards have been established by California and the federal government for the following criteria air pollutants: ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), particulate matter (PM_{10} and $PM_{2.5}$), sulfur dioxide (SO_2), and lead. These standards were established to protect sensitive receptors with a margin of safety from adverse health impacts due to exposure to air pollution. California has also established standards for sulfate, visibility, hydrogen sulfide, and vinyl chloride.

Air quality conditions in the San Francisco Bay Area have improved since the Air District was created in 1955. The Air District is in attainment of the State AAQS for CO, NO_2, and SO_2. However, the Air District does not comply with the State 24-hour PM_{10} standard, annual PM_{10} standard, and annual $PM_{2.5}$ standard. The Air District is unclassifiable/attainment for the federal CO, NO_2, SO_2, lead, and PM_{10} standards. A designation of unclassifiable/attainment means that the U.S. EPA has determined to have sufficient evidence to find the area either is attaining or is likely attaining the NAAQS.

The 2017 air quality data from Air District monitoring stations show that no monitoring stations measured an exceedance of any State or federal AAQS for CO and SO_2. There was one exceedance of the federal NO_2 AAQS at one monitoring station in 2017, although the area did not violate the NAAQS. All monitoring stations were in compliance with the federal PM_{10} standards. The State 24-hour PM_{10} standard was exceeded on six days in 2017, at the San Jose monitoring station.

The Bay Area is designated as a non-attainment area for the federal and state 8-hour ozone standard and the federal 24-hour $PM_{2.5}$ standard. The state and federal 8-hour ozone standards were exceeded on 6 days in 2017 at one site or more in the Air District; most frequently in the Eastern District (Livermore, Patterson Pass, and San Ramon) and the Santa Clara Valley. The federal 24-hour $PM_{2.5}$ standard was exceeded at one or more Bay Area station on 18 days in 2017, most frequently in the Napa, San Rafael, Vallejo, and San Pablo.

1.4.1.2 Air Quality Impacts

The Expedited BARCT implementation Schedule consists of six individual rule development projects that aim to control a variety of TACs and criteria pollutants in order to achieve the goals of AB 617. The Expedited BARCT Implementation Schedule is expected to result in a substantial reduction in criteria pollutant emissions, including approximately 75-125 tons per year of ROG emissions and 1,265 tons per year of SOx emissions. Additional criteria pollutant emission reductions are expected due to implementation of the Expedited BARCT Implementation Schedule and related control measures. However, the magnitude of the emissions reductions associated with some of the control measures is currently unknown.

Implementation of some of the control measures in the Expedited BARCT Implementation Schedule could involve retrofitting and replacing air pollution control equipment, which has the potential to create air quality impacts. Emissions from one pollutant may increase slightly in order to effectively reduce overall emissions.

Increases in criteria pollutant emissions could also occur as a consequence of efforts to improve air quality. Implementation of the Expedited BARCT Implementation Schedule would result in air emission increases associated with: (1) construction activities (e.g., to install air pollution control equipment); (2) air pollution control technologies that generates air emissions (e.g., oxidizers); and (3) transportation of materials (caustic, ammonia, and lime). As shown in Chapter 3.2, construction activities could generate ROG, NOx, PM_{10}, and $PM_{2.5}$ emissions that exceed the Air District's construction significance threshold. Therefore, construction air quality impacts are concluded to be significant, as well as cumulatively considerable. The impacts from operation of air pollution control equipment and methodologies to control criteria pollutant emissions under the Expedited BARCT Implementation Schedule are expected to be less than significant for all criteria pollutant emissions. Additionally, the project is expected to have quantifiable emissions benefits for both ROG and SOx emissions. For the remaining pollutants, the project is expected to provide emissions benefits, but because the benefits are not readily quantifiable, they have not been included in Chapter 3.2.

In general, it should be noted that while there are secondary TAC emissions increases associated with the operation of new air pollution control equipment (e.g., ammonia and caustic), a reduction in TAC emissions would also be expected. It is not possible to estimate those emission reductions at this point until the sources that will be controlled are more defined and the appropriate engineering analyses have been completed and so forth. Nonetheless, air pollution control equipment installed to control ROG emissions as a result of the proposed project (e.g., domes/vapor control on storage tanks) is expected to result in a reduction in TAC emissions from affected facilities.

1.4.2 HAZARDS AND HAZARDOUS MATERIALS

1.4.2.1 Hazards and Hazardous Materials Setting

The potential for hazards exist in the production, use, storage and transportation of hazardous materials. Hazardous materials may be found at industrial production and processing facilities. Some facilities produce hazardous materials as their end product, while others use such materials as an input to their production process. Examples of hazardous materials used as consumer products include gasoline, solvents, and coatings/paints. Hazardous materials are stored at facilities that produce such materials and at facilities where hazardous materials are a part of the production process. Currently, hazardous materials are transported throughout the district in great quantities via all modes of transportation including rail, highway, water, air, and pipeline.

The potential hazards associated with industrial activities are a function of the materials being processed, processing systems, and procedures used to operate and maintain the facility. The hazards that are likely to exist are identified by the physical and chemical properties of the materials being handled and their process conditions and include: (1) toxic gas clouds due to releases of volatile chemicals; (2) fires or explosions; (3) thermal radiation from the heat generated by a fire; and (4) explosion and overpressure when vessels containing flammable explosive vapors and potential ignition sources are combined.

In 2017, there were a total of 1,634 incidents reported in the nine counties regulated by the Air District, with the most incidents (388) reported in Alameda County, followed by Contra Costa County (313). Hazardous materials incidents during transportation, residential areas, and at waterways were the most common locations, respectively, for hazardous materials incidents. About 19 percent of the hazardous materials incidents that occurred within California occurred within the nine counties that comprise the Bay Area, with spills in industrial areas the most common (38 percent), followed by waterways (28 percent).

1.4.2.2 Hazards and Hazardous Materials Impacts

The Expedited BARCT Implementation Schedule would require facilities and refineries to install new or modify their existing air pollution control equipment or implement control measures. Additional hazard and hazardous material impacts are expected to result from the operation of several of the possible control technologies that would most likely be used. Facility modifications associated with the proposed project are expected to include additional lime injection at cement plants, increased LDAR in heavy liquid service at refineries, thermal incinerators, vapor combustors, vapor recovery units, the installation of SCRs, wet gas scrubbers, electrostatic precipitators, and/or LoTOx™ injection.

As discussed in Chapter 3.3.4, the increased use of hazardous materials including lime, caustic, and ammonia were determined to result in less than significant impacts for the increase in materials, as well as the related transportation hazards. The hazard impacts associated with the installation and operation of air pollution control equipment under the Expedited BARCT Implementation Schedule are expected to be less than significant.

1.4.3 HYDROLOGY AND WATER QUALITY

1.4.3.1 Hydrology and Water Quality Setting

The District is within the San Francisco Bay Hydrologic Region (Bay Region) which includes all of San Francisco County and portions of Marin, Sonoma, Napa, Solano, San Mateo, Santa Clara, Contra Costa, and Alameda counties. It occupies approximately 4,500 square miles; from southern Santa Clara County to Tomales Bay in Marine County; and inland to near the confluence of the Sacramento and San Joaquin rivers at the eastern end of Suisun Bay. The eastern boundary follows the crest of the Coast Ranges, where the highest peaks are more than 4,000 feet above mean sea level.

The most prominent surface water body in the Bay Region is San Francisco Bay itself. Other surface water bodies include: Creeks and rivers; ocean bays and lagoons (such as Bolinas Bay and Lagoon, Half Moon Bay, and Tomales Bay); urban lakes (such as Lake Merced and Lake Merritt); human-made lakes and reservoirs (such as Lafayette Reservoir, Briones Reservoir, Calaveras Reservoir, Crystal Springs Reservoir, Kent Lake, Lake Chabot, Lake Hennessey, Nicasio Reservoir, San Andreas Lake, San Antonio Reservoir, San Pablo Reservoir, Upper San Leandro Reservoir, Anderson Reservoir, and Lake Del Valle).

Local water supplies account for about 31 percent of the total, and the remaining water supply is imported from the State Water Project (SWP) (13 percent), Central Valley Project (CVP) (15 percent), the Mokelumne watershed (19 percent), and the Tuolumne watersheds (19 percent). Some Bay Area water agencies are projecting future water supply shortfalls in dry years (including Alameda County Water District -2020, Santa Clara Valley Water District – 2040, and Sonoma County Water Agency – 2025), and some are already seeing such shortfalls (including East Bay Municipal Utility District, City of Napa Water Department, and Solano County Water Agency). Other agencies anticipate being able to handle a single dry year, largely because of reservoirs, or other storage capacity, including Contra Costa Water District, Marin Municipal Water District, San Francisco Public Utilities Commission, and Zone 7 Water Agency. The severity and timing of dry year shortfalls differ greatly among the agencies because of the wide variation of supply sources, types of use, and climates within the region. Shortages in precipitation in the Sierra Nevada can have a pronounced effect on water supply in the region than a drought in the Bay Area itself because of the reliance of the region on water from the Tuolumne and Modelumne watersheds.

Wastewater treatment in the Bay Area is provided by various agencies as well as individual city and town wastewater treatments. Some treatment plants serve individual cities while others serve multiple jurisdictions. More than 50 agencies provide wastewater treatment throughout the Bay Area. Each plant is typically sized to accommodate growth over a 15- to 20-year period. In addition, a number of industrial facilities also have wastewater treatment facilities, e.g., refineries.

1.4.3.2 Hydrology and Water Quality Impacts

It is expected that affected industrial facilities would install new or modify existing air pollution control equipment to comply with the Expedited BARCT Implementation Schedule. Most air pollution control equipment does not use water or generate wastewater. However, additional water demand and wastewater generation impacts are expected to result from the operation of wet gas scrubbers and/or wet ESPs, which may be used to control refinery FCCUs and coke calciners, and water to make the lime slurry to control emissions from the cement kiln.

Water demand impacts from installing up to three WGS systems on refinery FCCUs, additional lime injection on a cement kiln, and a LoTOX on a coke calciner may exceed applicable water demand significance thresholds and, therefore, water demand impacts are concluded to be significant, as well as cumulatively considerable. Mitigation measures were imposed that required the use of recycled water, if available, and a written declaration from the local water purveyor, if recycled water cannot be supplied to the applicable air pollution control equipment. In spite of implementing the identified mitigation measures, water demand impacts during operation of the proposed project remain significant, in part because there is currently no guarantee that reclaimed water will be available to all of the affected facilities and because of the prevalence of drought conditions in California. Therefore, impact of the proposed project will remain significant, as well as cumulatively considerable, after mitigation for water demand.

Water quality impacts from installing most types of air pollution control equipment that use water as part of the control process would not exceed applicable water quality significance thresholds and, therefore, are concluded to be less than significant.

1.5 EXECUTIVE SUMMARY: CHAPTER 4 – ALTERNATIVES

An EIR is required to describe a reasonable range of feasible alternatives to the proposed project that could feasibly attain most of the basic project objectives and would avoid or substantially lessen any of the significant environmental impacts of the proposed project (CEQA Guidelines §15126.6(a)). As discussed in Chapter 4 of this EIR, the proposed project could result in potentially significant impacts to: (1) air quality during construction; and (2) water demand associated with operation of additional air pollution control equipment. An EIR is required to describe a reasonable range of feasible alternatives to the proposed project that could feasibly attain most of the basic project objectives and would avoid or substantially lessen any of the significant environmental impacts of the proposed project (CEQA Guidelines §15126.6(a)).

Under Alternative 1, the No Project Alternative, no additional air pollution control equipment or measures (e.g., monitoring/repair of fugitive heavy liquid leaks) would be implemented. Alternative 1 would not comply with AB 617, which requires air districts to review the emissions control technology installed on pollution sources located at industrial facilities subject to the Cap-and-Trade program and implement BARCT at affected facilities. Alternative 1 would not comply with the AB 617 requirements and would not be considered feasible at this time. It should be noted that it would be unlikely that the District would remain out of compliance with AB 617 indefinitely and some action would likely be taken in the future to comply. Nonetheless, for the purpose of comparison and public disclosure, it will be assumed that no action will be taken under the No Project Alternative.

Alternative 2 would delay the Expedited BARCT Implementation Schedule so that all rules would not be implemented until 2023, which is the deadline for implementing BARCT air pollution control measures required under AB 617. Therefore, the overlap of construction activities would be expected to be reduced; however, there will be a loss of operational emissions benefits (emissions reductions) for several years as compared to the proposed project.

Alternative 1 would eliminate the potentially significant ROG, NOx, PM_{10}, and $PM_{2.5}$ impacts associated with construction activities to less than significant, but would not achieve any of the proposed project objectives. Alternative 2 would reduce the potentially significant ROG, NOx, PM_{10}, and $PM_{2.5}$ impacts associated with construction activities, but not to less than significant levels, and the water demand impact would be the same as the proposed project; however, Alternative 2 would achieve all of the project objectives. Since Alternative 2 would reduce the potentially significant ROG, NOx, PM_{10}, and $PM_{2.5}$ impacts and achieve the project objectives, Alternative 2 would be considered the environmentally superior alternative.

The proposed project would be considered the preferred alternative as it would achieve all of the project objectives and emission reductions associated with the implementation of BARCT on the affected facilities and the emission reductions would be expected to occur two years earlier than under Alternative 2, providing an additional two years-worth of emissions benefits.

1.6 EXECUTIVE SUMMARY: CHAPTER 5

Chapter 5 provides the references used in the preparation of the EIR.

TABLE 1-1

Summary of Environmental Impacts, Mitigation Measures and Residual Impacts

Impact	Mitigation Measures	Residual Impacts
Air Quality		
The construction activities required as a result of the Expedited BARCT Implementation Schedule may result in ROG, NOx, PM_{10}, and $PM_{2.5}$ emissions that would exceed the significance thresholds resulting in potentially significant air quality impacts.	Minimize emissions from vehicles and trucks; limit truck idling; maintain construction equipment to manufacturer's recommendations; identify construction areas served by electricity; use cranes rated 200 hp or greater with Tier 4 engines or equivalent (if available); and use off-road equipment rated 50 to 200 hp with Tier 4 or equivalent engines (if available).	ROG, NOx, PM_{10}, and $PM_{2.5}$ emission impacts during construction activities are potentially significant under the Expedited BARCT Implementation Schedule following mitigation, but are short-term and would cease when construction activities are complete.
Operational activities that may be required as a result of the Expedited BARCT implementation Schedule are expected to result in emissions of ROG, CO, NOx, SOx, PM_{10}, and $PM_{2.5}$ that would result in less than significant impacts. In addition the project would result in substantial reductions in ROG (75-125 tons/yr) and SOx (1,265 tons/yr). Additional emission reductions are expected but the magnitude of the reductions is currently unknown.	None required.	Operational emissions of ROG, CO, NOx, SOx, PM_{10}, and $PM_{2.5}$ would result in less than significant impacts.
Potential TAC emissions increases associated with implementation of the Expedited BARCT implementation Schedule are expected to result in less than significant impacts. Additional TAC emission reductions are expected but the magnitude of the reductions is currently unknown.	None required.	Impacts from potential TAC emissions under the Expedited BARCT Implementation Schedule would be less than significant.

TABLE 1-1

Summary of Environmental Impacts, Mitigation Measures and Residual Impacts

Impact	Mitigation Measures	Residual Impacts
Hazards and Hazardous Materials		
Hazard impacts from air pollution control equipment, including fire or explosion impacts from the use of dry ESPs, are expected to be less than significant under the Expedited BARCT implementation Schedule.	None required.	Hazard impacts associated with the use of air pollution control equipment would remain less than significant.
Transportation and use of hazardous materials in WGSs, lime injection systems, and SCRs are expected to result in less than significant impacts under the Expedited BARCT Implementation Schedule	None required.	Impacts from transportation and use of hazardous materials would remain less than significant.
Hydrology and Water Quality		
The potential water demand associated with air pollution control equipment, particularly refinery wet gas scrubbers/ESPs, lime injection, and LoTOx, could result in a significant impact on water demand associated with the Expedited BARCT Implementation Schedule.	Mitigation measures include the requirement to use reclaimed or recycled water, if available.	Water demand impacts are expected to remain significant as the use of reclaimed or recycled water cannot be assured.
Wastewater generated from the installation of air pollution control equipment to comply with the Expedited BARCT Implementation Schedule is not expected to exceed any applicable water quality significance thresholds. Therefore, no wastewater impacts are expected.	None required.	Wastewater impacts are expected to remain less than significant.

CHAPTER 2

PROJECT DESCRIPTION

Introduction
Project Location
Project Objectives
Background and Project Description

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2.0 PROJECT DESCRIPTION

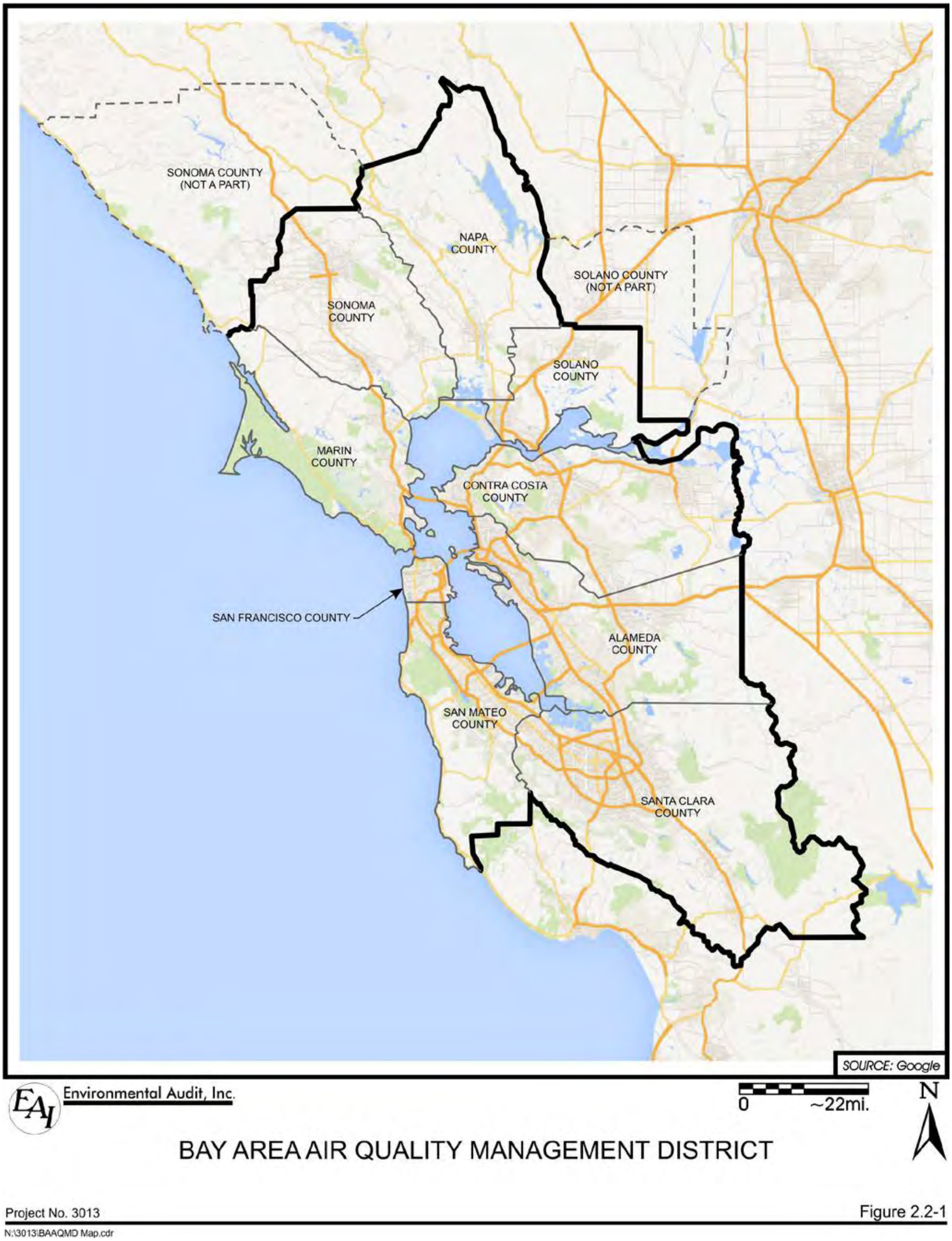
2.1 INTRODUCTION

The Bay Area Air Quality Management District (District), in accordance with Assembly Bill 617, (AB 617) is preparing the best available retrofit control technology (BARCT) implementation schedule project (project or proposed project). AB 617 requires each air district that is a nonattainment area for one or more air pollutants to adopt an expedited schedule for implementation of best available retrofit control technology (BARCT) by the earliest feasible date. This requirement applies to each industrial source subject to California Air Resources Board's (CARB's) Greenhouse Gas (GHG) Cap-and-Trade requirements.

The purpose of the proposed project is to reduce criteria pollutant emissions from industrial sources that participate in CARB's GHG Cap-and-Trade program. The Cap-and-Trade program is designed to address and limit GHG emissions, and allows sources to comply with Cap-and-Trade limits by either reducing emissions at the source or purchasing GHG emission allowances. Emissions of criteria pollutants and toxic air contaminants are often associated with GHG emissions, and these criteria pollutants and toxic air contaminants may impact local communities that are already suffering a disproportionate burden from air pollution.

2.2 PROJECT LOCATION

The BAAQMD has jurisdiction of an area encompassing 5,600 square miles. The Air District includes all of Alameda, Contra Costa, Marin, San Francisco, San Mateo, Santa Clara, and Napa Counties, and portions of southwestern Solano and southern Sonoma counties. The San Francisco Bay Area is characterized by a large, shallow basin surrounded by coastal mountain ranges tapering into sheltered inland valleys. The combined climatic and topographic factors result in increased potential for the accumulation of air pollutants in the inland valleys and reduced potential for buildup of air pollutants along the coast. The Basin is bounded by the Pacific Ocean to the west and includes complex terrain consisting of coastal mountain ranges, inland valleys and bays (see Figure 2.2-1).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CONTRA COSTA
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BAY AREA AIR QUALITY MANAGEMENT DISTRICT
Project No. 3013
Figure 2.2-1
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2.3 PROJECT OBJECTIVES

The objectives of the Expedited BARCT Implementation Schedule are to:

- Implement and/or install best available retrofit control technologies;
- Reduce criteria pollutant emissions from significant industrial sources that participate in Cap and Trade; and
- Lessen the burden of air quality impacts on communities that suffer a disproportionate burden from air pollution.

2.4 BACKGROUND AND PROJECT DESCRIPTION

2.4.1 BACKGROUND

With the adoption of AB 617, the state acknowledges that many communities around the state continue to experience disproportionate impacts from air pollution. To address these impacts, AB 617 directs all air districts that are in nonattainment areas to apply BARCT to all industrial sources subject to Cap-and-Trade, and to identify communities with a "high cumulative exposure burden" to air pollution. Districts must then prioritize these communities for the development of community air monitoring projects and/or emission reduction programs. The State requires that monitoring campaigns and emission reduction programs be developed through a community-based process.

The purpose of the proposed project is to reduce criteria pollutant emissions from industrial sources that participate in the GHG Cap-and-Trade system. The Cap-and-Trade system is designed to address and limit GHG emissions, and allows sources to comply with Cap-and-Trade limits by either reducing emissions at the source or purchasing GHG emission allowances. The Cap-and-Trade program includes particular provisions for "industrial" facilities, which are covered entities or facilities that are eligible for free allowance allocation. Under the Cap-and-Trade program, these free allocations are provided to certain industrial sectors to minimize potential leakage of economic activity and GHG emissions. Emissions of criteria pollutants and toxic air contaminants are often associated with GHG emissions, and these criteria pollutants and toxic air contaminants may impact local communities that are already suffering a disproportionate burden from air pollution.

The proposed project aims to implement rule development projects that will require the use of BARCT for specific equipment in industrial facilities that are subject to GHG Cap-and-Trade requirements in order to reduce criteria pollutant emissions. A summary of the AB617 requirements is outlined below.

- Air districts in nonattainment areas must implement BARCT on all industrial sources subject to the AB 32 Cap-and-Trade Program.

- The California Air Resources Board (CARB) must establish and maintain a clearinghouse of best available control technology (BACT), and BARCT.
- Air pollution violation maximum penalties were increased, and will adjust with inflation.
- CARB must prepare an air monitoring plan for all areas of the state by October 1, 2018.
- Based on air monitoring plan information, CARB must select communities with high cumulative exposure burden to both toxic and criterial air pollutants by July 1, 2019.
    - Each air district with a high cumulative burden community must deploy a community air monitoring system in that community within one year, and provide the air quality data to CARB for publication.
- By January 1, 2020, and each January 1 thereafter, CARB will select additional communities with high cumulative exposure burden.
    - Each air district with a high burden community must deploy a community air monitoring system in that community within one year, and provide the air quality data to CARB for publication.
- CARB must prepare a state-wide strategy to reduce emissions of toxic and criteria pollutants in communities affected by high cumulative exposure burden, by October 1, 2018, and update the strategy every five years. Criteria for the state-wide strategy include:
    - Disadvantaged communities and sensitive receptor locations are a priority.
    - A methodology for assessing and identifying contributing sources, and estimating their relative contribution to elevated exposure (source apportionment).
    - Assessment of whether an air district should update and implement the risk reduction audit and emissions reduction plan for any facility if the facility causes or significantly contributes to the high cumulative exposure burden.
    - Assessment of available measures for reducing emissions including BACT, BARCT, and best available control technology for toxics (TBACT).
- CARB will select locations for preparation of Community Emission Reduction Plans by October 1, 2018. CARB will select additional locations annually thereafter.
    - Within one year, the air district will adopt Community Emission Reduction Plans in consultation with CARB, individuals, community-based organizations, affected sources, and local governmental bodies.
    - The Community Emission Reduction Plans must be consistent with the state-wide strategy, and include emission reduction targets, specific reduction measures, a schedule for implementation of the measures, and an enforcement plan.
    - The Community Emission Reduction Plans must be submitted to CARB for review and approval.
    - The Community Emission Reduction Plans must achieve emission reductions in the community, based on monitoring or other data.

    - The air district must prepare an annual report summarizing the results and actions taken to further reduce emissions.
- CARB will provide grants to community-based organizations for technical assistance and to support community participation in identification of communities with high exposure burden, and development and implementation of the Community Emission Reduction Plans.

AB 617 represents a significant enhancement to the approach CARB and local air districts take in addressing local air quality issues. The Air District has implemented and established a number of programs that support the goals and intent of AB 617; these programs include the Community Air Risk Evaluation (CARE) Program, Health Risk Assessments for the AB 2588 Air Toxics "Hot Spots" Program, and Air District Rule 11-18: Reduction of Risk from Air Toxic Emissions at Existing Facilities. However, the requirements of AB 617 formalize the requirements and establish goals and timelines for implementation.

2.5 PROJECT DESCRIPTION

The Expedited BARCT Implementation Schedule will consist of the implementation of several rule development projects in order to fulfill the requirements of AB 617. The Bay Area air basin is in attainment with both the National Ambient Air Quality Standards and California Ambient Air Quality Standards for carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and lead. The air basin is designated as nonattainment for ozone (O_3) and particulate matter ($PM_{2.5}$ and PM_{10}) under California ambient air standards, therefore, the BARCT review was conducted focusing on the following pollutants:

- Nitrogen Oxides (NOx)
- Reactive Organic Gases (ROG)
- Particulate Matter less than 10 microns (PM_{10})
- Particulate Matter less than 2.5 microns ($PM_{2.5}$)
- Sulfur Dioxide (SO_2)

NOx and ROG are included because they are precursors for ozone formation. SO_2 may contribute to the formation of condensable PM (i.e. formed in the emissions plume from the stack) at certain types of sources, so PM control strategies may include SO_2 limits.

A list of facilities, sources, and emissions were developed from the 2016 Reporting Year Emissions Inventory. The Bay Area has 80 facilities subject to Cap-and-Trade, which encompass 3,246 individual sources in 61 source categories. This list of facilities was reduced to 19 "industrial" facilities, which includes all covered entities that are eligible for free allowance allocations in accordance with the Cap-and-Trade requirements based on their engagement in an activity within a particular North American Industrial Code System (NAICS) Code listed in Table 8-1 of the Cap-and-Trade regulation (17 CCR § 95890(a)). These 19 industrial Cap-and-Trade facilities encompass 1,899 individual sources in 50 source categories. These sources were reviewed for the amount of emissions and existing controls that may already comply with BARCT. After screening for these sources with emissions greater than 10 pounds per day and sources that have not already achieved BARCT, the population of sources was reduced to the following:

- NOx: 21 source categories, 73 sources representing 30% of the emissions (1,764 tpy)
- ROG: 23 source categories, 259 sources representing 93% of the emissions(2,430 tpy)
- PM: 16 source categories, 124 sources representing 92% of the emissions (1,851 tpy)
- SO_2: 15 source categories, 102 sources representing 71% of the emissions (3,651 tpy)

The Air District reviewed available information on current achievable emission limits and potential controls for each source category and pollutant. This information included guidelines and recent determinations of BACT, reasonably available control technology (RACT), and lowest achievable emission rate (LAER) from EPA, CARB, and other air districts. Six potential priority rule development projects have been identified for inclusion in the Expedited BARCT Implementation Schedule. Potential priority rule development projects are shown in Table 2-1.

TABLE 2-1 – BARCT Rule Development Projects

PROPOSED RULE DEVLOPMENT PROJECTS – EXPEDITED BARCT IMPLEMENTATION SCHEDULE		
Project Name	**Pollutant**	**Rule Development Project Summary**
Organic Liquid Storage Tanks	ROG TACs	Regulation 8, Rule 5: Storage of Organic Liquids may be amended to specifically address ROGs and TACs emissions from external floating roof tanks storing organic liquids. Emission reductions are expected from installing domes on external floating roof tanks and capturing emissions from internal floating roof tanks or coned roof tanks and removing ROG emissions through a vapor recovery unit to a thermal incinerator.
Petroleum Wastewater Treating	ROG	The Air District has addressed ROG emissions from petroleum wastewater treatment facilities (Rule 8-8 Wastewater Collection and Separation Systems) in previous rule developments. This project will review each of the five Bay Area refineries for any opportunities for reduction of wastewater ROG's. BACT for refinery wastewater systems includes the use of entirely enclosed systems in addition to good control practices.
Portland Cement Manufacturing	PM SO_2	BARCT levels are still under development for condensable PM emissions from cement kilns; however, controls will likely involve the reduction of SO_2, ammonia, or other condensable components and precursors. Expedited BARCT implementation for SO_2 emissions reductions includes the judicious selection and use of raw materials, dry scrubbing, and dry sorbent (lime) injection.
Refinery Fluid Catalytic Crackers and CO Boilers	PM SO_2	PM and SO_2 emissions reductions are expected through optimization of ammonia injection, additional ESP capacity, optimization of newer catalyst additives, and/or wet gas scrubbing.
Refinery Heavy Liquid Leaks	ROG	Amendments to Regulation 8, Rule 18: Equipment Leaks (Rule 8-18) in December 2015 addressed equipment that service heavy liquids at these sources, but those amendments have not yet been fully implemented due to litigation regarding uncertainty of heavy liquid fugitive emissions. BAAQMD is coordinating with each of the five Bay Area refineries to conduct a Heavy Liquid Leak Study. The study is designed to determine appropriate emission factors for heavy liquid leaks. The results of the study are expected by Fall 2018. BARCT levels will likely be set after the study has concluded; implementation is expected to involve additional leak detection and repair (LDAR) provisions for components in heavy liquid service.
Petroleum Coke Calcining	NOx	Regulation 9, Rule 14: Petroleum Coke Calcining Operations (Rule 9-14), which currently only addresses SO_2 emissions, may be amended to address NOx emissions. Technologies available for NOx reduction in petroleum coke calcining operations is expected to include SCRs and LoTOx injection systems.

2.6 SOURCES THAT MAY BE SUBJECT TO BARCT

The overall purpose of the Expedited BARCT Implementation Schedule is to reduce criteria pollutant emissions from industrial sources that participate in CARB's GHG Cap-And-Trade program. Emission of criteria pollutants and toxic air contaminants are often associated with GHG emissions, and these criteria pollutants and toxic air contaminants may impact local communities. Expedited BARCT implementation would apply to a wide range of commercial and industrial facilities including petroleum refineries, chemical plants and manufacturing operations. Table 2-2 shows the most likely types of facilities anticipated to be subject to BARCT and the primary emissions that would be controlled.

TABLE 2-2

Summary of Facilities and Sources Where BARCT May Apply Under the Expedited BARCT Requirements

Facility	Sources	Pollutants Controlled
Refineries	Fugitive Emissions (tanks, valves, pumps, compressors) Fluidized Catalytic Cracking Units CO Boilers Wastewater Treatment Operations	ROG PM SO_2
Petroleum Coke Calcining	Coke Calciners	NOx
Cement Manufacturing	Cement Kiln	PM SO_2
Refineries, Chemical Plants, Bulk Storage and Transfer Operations, and General Manufacturing	Organic Liquid Storage Tanks	ROG

2.6.1 REFINERIES

Petroleum refineries convert crude oil into a wide variety of refined products, including gasoline, aviation fuel, diesel and other fuel oils, lubricating oils, and feed stocks for the petrochemical industry. Crude oil consists of a complex mixture of hydrocarbon compounds with smaller amounts of impurities including sulfur, nitrogen, oxygen and metals (e.g., iron, copper, nickel, and vanadium). Crude oil that originates from different geographical locations may vary with respect to its composition, thus, potentially generating different types and amounts of emissions. The types of equipment where BARCT may be applied under the expedited BARCT requirements are further described below.

Fugitive Emissions Sources: Petroleum refineries include a large number and wide variety of fugitive emissions sources. Fugitive emissions are emissions of gases or vapors from pressurized equipment due to leaks and other unintended or irregular releases of gases during the crude refining process and do not include pollutants vented to an exhaust stack before release to the atmosphere. Generally, any processes or transfer areas where leaks can occur are sources of fugitive emissions. Fugitive emissions sources include, but are not limited to the following: valves, connectors (i.e., flanged, screwed, welded or other joined fittings), pumps, compressors, pressure relief devices, and diaphragms in ROG service. Fugitive emissions are generally controlled through leak detection and repair (LDAR) programs. Similarly, tanks storing crude oil or petroleum products also produce fugitive emissions.

Fluid Catalytic Cracking Units (FCCUs) and CO Boilers: FCCUs are complex processing units that convert heavy components of crude oil into light, high-octane products that are required in the production of gasoline. Each FCCU consists of a reaction chamber, a catalyst regenerator, and a fractionator. The cracking process begins in the reaction chamber were fresh catalyst is mixed with pre-heated heavy oils. A chemical reaction occurs that converts the heavy oil into a cracked hydrocarbon vapor mixed with catalyst. As the cracking reaction progresses, the cracked hydrocarbon vapor is routed to a distillation column or fractionator for further separation into lighter hydrocarbon components such as light gases, gasoline, light gas oil, and cycle oil. The catalyst becomes coated with carbonaceous material (coke) during its exposure to the hydrocarbon feedstock. FCCUs include a catalyst regenerator where coke is burned off the surface of the catalyst to restore its activity so it can be re-used. Catalyst regenerators may be designed to burn the coke completely to carbon dioxide (full burn) or to only partially burn the coke to a mixture of CO and CO_2 (partial burn). Because the flue gas from these partial burn regenerators has high levels of CO, the flue gas is vented to a CO boiler where the CO is further combusted to CO_2. FCCUs and associated CO boilers can generate substantial PM, NOx, and SO_2 emissions.

Petroleum Wastewater Treating: All refineries employ some form of wastewater treatment, so water effluents can safely be reused at the refinery or discharged. Wastewater treatment operations provide a means of treating water that has come into contact with petroleum hydrocarbons, and, as such, are a potential source of ROG emissions. The design of wastewater treatment plants is complicated by the diversity of refinery pollutants, including oil, phenols, sulfides, dissolved, solids, and toxic chemicals. Although the treatment processes employed by refineries vary greatly they generally include drain systems, neutralizers, oil/water separators, settling chambers, clarifiers, dissolved air flotation systems, coagulators, and activated sludge units.

Drain systems consist of individual process drains, where oily water from various sources is collected, and junction boxes, which receive the oily water from multiple drains. The first stage of a typical wastewater treatment process is the oil-water separator, which physically separates the free oil and solids from the water. Gravity allows any oil in the water to rise to the surface of the separator and any solid particles to sink to the bottom. A continually moving scraper system pushes oil to one end and the solids to the other. Both are removed and the recovered oil is sent back to the refinery for reprocessing. Small suspended oil particles are then typically removed in the dissolved air flotation unit. Wastewater is sent to the activated sludge units, where naturally-occurring microorganisms feed on the dissolved organics in the wastewater, and convert them to water, CO_2 and nitrogen gas, which can be safely released into the atmosphere. Finally, wastewater enters the clarifying tanks, where the microorganisms settle to the bottom while the treated wastewater flows away.

2.6.2 PETROLEUM COKE CALCINING

Petroleum coke, the heaviest portion of crude oil, cannot be recovered in the normal refining process. Instead, petroleum coke is processed in a delayed coker unit to generate a carbonaceous solid referred to as “green coke,” a commodity. To improve the quality of the product, if the green coke has a low metals content, it will be sent to a calciner to make calcined petroleum coke. Calcined petroleum coke can be used to make anodes for the aluminum, steel, and titanium smelting industry. If the green coke has a high metals content, it can be used as a fuel grade coke by the fuel, cement, steel, calciner and specialty chemicals industries.

The process of making calcined (removing impurities) petroleum coke begins when the green coke feed from the delayed coker unit is screened and transported to the calciner unit where it is stored in a covered coke storage barn. The screened and dried green coke is introduced into the top end of a rotary kiln and is tumbled by rotation under high temperatures that range between 2,000 and 2,500 degrees Fahrenheit (^oF). The rotary kiln relies on gravity to move coke through the kiln countercurrent to a hot stream of combustion air produced by the combustion of natural gas or fuel oil. As the green coke flows to the bottom of the kiln, it rests in the kiln for approximately one additional hour to eliminate any remaining moisture, impurities, and hydrocarbons. Hot gases from the calciner are sent to a pyroscrubber that removes particulates through a combination of settling and incineration and sulfur compounds are oxidized to SO_2. Once discharged from the kiln, the calcined coke is dropped into a cooling chamber, where it is quenched with water, treated with de-dusting agents to minimize dust, and carried by conveyors to storage tanks and sold for industrial uses.

2.6.3 CEMENT MANUFACTURING

Cement is manufactured in a cement kiln using a pyroprocess or high temperature reactor that is constructed along a longitudinal axis with segmented rotating cylinders whose connected length is anywhere from 50 to 200 yards in length. The pyroprocess in the kiln consists of three phases during which clinker is produced from raw materials undergoing physical changes and chemical reactions. The first phase in the kiln, the drying and pre-heating zone, operates at a temperature between 1,000 ^oF and 1,600 ^oF and evaporates any remaining water in the raw mix of materials entering the kiln. The second phase, the calcining zone, operates at a temperature between 1,600 ^oF and 1,800 ^oF and converts the calcium carbonate from the limestone in the kiln feed into calcium oxide and releases CO_2. During the third phase, the burning zone operates on average at 2,200 ^oF to 2,700 ^oF (though the flame temperature can at times exceed 3,400 ^oF) during which several reactions and side reactions occur. As the materials move towards the discharge end, the temperature drops and eventually clinker nodules form and volatile constituents, such as sodium, potassium, chlorides, and sulfates, evaporate. The red-hot clinker exits the kiln, is cooled in the clinker cooler, passes through a crusher and is conveyed to storage.

As indicated above cement manufacturing occurs at high temperatures using several combustion fuels. Fuels that have been used for primary firing include coal, petroleum coke, heavy fuel oil, natural gas, landfill off-gas and oil refinery flare gas. High carbon fuels such as coal are preferred for kiln firing, because they yield a luminous flame. The clinker is brought to its peak temperature mainly by radiant heat transfer, and a bright (i.e. high emissivity) and hot flame is essential for this. Combustion emissions are exhausted through the kiln's stack.

Relative to cement manufacturing, fugitive dust is wind-driven particulate matter emissions from any disturbed surface work area that are generated by wind action alone.

The process of making cement begins with the acquisition of raw materials, predominantly limestone rock (calcium carbonate) and clay, which exist naturally in rocks and sediment on the earth's surface. These and other materials used to manufacture cement are typically mined at nearby quarries and comprise "raw mix." The raw mix is refined by a series of mechanical crushing and grinding operations to segregate and eventually reduce the size of each component to 0.75 inch or smaller before being conveyed to storage.

2.6.4 ORGANIC LIQUID STORAGE FACILITIES

Storage vessels containing organic liquids can be found in many industries, including: (1) petroleum producing and refining; (2) petrochemical and chemical manufacturing; (3) bulk storage and transfer operations; and (4) other industries consuming or producing organic liquids. Organic liquids in the petroleum industry generally are mixtures of hydrocarbons having dissimilar true vapor pressures (for example, gasoline and crude oil). Organic liquids in the chemical industry are composed of pure chemicals or mixtures of chemical with similar vapor pressures (for example, benzene or a mixture of isopropyl and butyl alcohols).

Six basic tank designs are used for organic liquid storage vessels: fixed roof (vertical and horizontal), external floating roof, domed external (or covered) floating roof, internal floating roof, variable vapor space, and pressure tanks (low and high). Tanks associated with refineries comprise over 95 percent of the AB 617 organic liquid storage tanks.

ROG emissions from organic liquids in storage occur because of evaporative loss of the liquid during its storage and as a result of changes in the liquid level. ROG emissions vary with tank design, as does the relative contribution of each type of tank. Emissions from fixed roof tanks are a result of evaporative losses during storage (breathing losses or standing storage losses) and evaporative losses during filling and emptying operations (referred to as working losses). External and internal floating roof tanks are ROG emission sources because of evaporative losses that occur during standing storage and withdrawal of liquid from the tank. Standing storage losses are a result of evaporative losses through rim seams, deck fittings, and/or deck seams. Pressure tank losses occur when connecting to or disconnecting from the tank.

2.7 BARCT EMISSION CONTROL TECHNOLOGIES

The expedited implementation of BARCT would apply to existing facilities in the Bay Area that are generally large sources of emissions and included in the CARB GHG Cap-and-Trade program as industrial facilities. The overall purpose of the Expedited BARCT Implementation Schedule is to reduce criteria pollutant emissions from industrial sources that participate in the GHG Cap-and-Trade program. Emissions of criteria pollutants and TACs are often associated with GHG emission sources.

To comply with the BARCT requirements for affected facilities, operators could reduce operations or install BARCT equipment, which are different types of air pollution control equipment or measures. The type of emission capture and control technology that may be used depends on the specific type of pollutant to be controlled. The most common air pollution control measures that are likely to be encountered as a result of the proposed implementation of expedited BARCT are categorized into the following groups and are summarized in Table 2-3:

- Installing domes on external floating roof tanks and capturing vented emissions from internal floating roof tanks or coned roof tanks and removing ROG emissions through a vapor recovery unit;
- Covering lift stations, manholes, junction boxes, conveyances and other wastewater facilities at refineries and venting ROG emissions to a vapor combustor;
- Requiring additional lime injection on cement kilns to control SO_2 in order to reduce condensable PM emissions;
- Control PM emissions from FCCUs using SO_2 reducing catalyst additives, additional ESP capacity, or wet gas scrubbers;
- Reducing ROG emissions from fugitive components in heavy liquid service at refineries through increased LDAR programs;
- Reducing NOx emissions from coke calcining facilities through the use of SCR units and/or LoTOx system with a wet scrubber.

TABLE 2-3

Expedited BARCT Measures and Target Substances

BARCT Measure	Pollutant
Additional Controls on Organic Liquid Storage Tanks	ROG
Enclosures and Vapor Combustors at Refinery Wastewater Treatment Plants	ROG
Additional Lime Injection at Cement Plants Systems	PM and SO_2
Wet Gas Scrubbers, ESPs, and SO_2 Reducing Catalysts at Refinery FCCUs and CO Boilers	PM and SO_2
Increase LDAR for Equipment in Heavy Liquid Service Refineries	ROG
SCR and LoTOx (wet scrubber) at Petroleum Coke Calciners	NOx

The following subsections briefly describe the most likely types of control technologies that would be used to comply with the expedited BARCT measures. Table 2-4 summarizes the estimated number of each type of air pollution control technology that may be used to meet emissions reductions under the expedited BARCT requirements for the purposes of this EIR.

TABLE 2-4

Expedited BARCT Expected Air Pollution Control Equipment

Type of Air Pollution Control	Number of Units Potentially Installed Under Expedited BARCT	Notes/Comments
Vapor Recovery Unit and/or Thermal Incinerator on Organic Liquid Storage Tanks	Up to 20 domes, and up to 10 VRU/Incinerators	
Vapor Combustor on Refinery Wastewater Treatment Plants	Up to 5	Assumes that a refinery would implement one system for their wastewater treatment plant, and potentially all 5 refineries would need some type of control
Additional Lime Injection at Cement Plants	1	
Wet Gas Scrubbers/ESPs	Up to 3	Assumes highest impact scenario would involve WGS/ESP installation on up to 3 FCCUs
Increased LDAR in Heavy Liquid Service at Refineries	5	Increased scope of LDAR will likely impact all 5 refineries
SCR or LoTOX (wet scrubber) at Petroleum Coke Calciners	1	

2.7.1 Additional Controls on Organic Liquid Storage Tanks

ROG emissions from organic liquids in storage occur because of evaporative loss of the liquid during its storage and as a result of changes in the liquid level. ROG emissions vary with tank design, as does the relative contribution of each type of emission source.

Potential ROG emission reductions would be achieved by installing domes on external floating roof tanks and capturing vented emissions from internal floating roof tanks or coned roof tanks and removing ROG emissions through a vapor recovery unit (VRU) flowing back to the tank for recovery or to a thermal incinerator. Thermal oxidizers, or thermal incinerators, are combustion devices that control ROG and volatile TAC emissions by combusting them to CO_2 and water. Domed roofs on external floating roofs without VRUs would reduce ROG emissions by limiting wind effects.

2.7.2 Enclosures and Vapor Combustors at Refinery Wastewater Treatment Plants

The main component of atmospheric emissions from refinery wastewater treatment plants are fugitive ROG emissions and dissolved gases that evaporate from the surfaces of wastewater residing in open process drains, separators, and ponds. The control of wastewater treatment plant emissions involves covering systems where emission generation is greatest (such as oil/water separators and settling basins) and removing dissolved gases from water streams with sour water strippers before contact with the atmosphere. Covering wastewater operations potentially can achieve greater than 90 percent reduction of wastewater system emissions. In addition, all lift stations, manholes, junction boxes, conveyances and any other wastewater facilities should be covered and all emissions routed to a vapor combustor with a destruction removal efficiency (DRE) of 99 percent for control. Vapor combustors are combustion devices that control ROG emissions by combusting them to carbon dioxide and water.

2.7.3 Lime Injection at Cement Plants

The formation of SO_2 in cement kilns is a product of the chemical make-up of the raw materials and fuel, as well as the high operating temperatures and oxygen concentration in the kiln. In a lime injection system, hydrated lime powder is injected into the flue gas. SO_2 reacts with lime (calcium carbonate) and is captured in the baghouse as calcium sulfate. The hydrated lime usually absorbs up to 60% of the SO_2 in the gases if injected at the correct temperature. The one cement kiln in the District currently operates a lime injection system for the control of hydrochloride emissions. The use of additional lime injection is expected to reduce SO_2 emissions even further.

2.7.4 Wet Gas Scrubbers

In wet scrubbing processes, liquid or solid particles are removed from a gas stream by transferring them to a liquid. This addresses only wet scrubbers for control of particulate matter. The liquid most commonly used is water. A wet scrubber's particulate collection efficiency is directly related to the amount of energy expended in contacting the gas stream with the scrubber liquid. Most wet scrubbing systems operate with particulate collection efficiencies over 95 percent (U.S. EPA, 2017).

There are three energy usage levels for wet scrubbers. A low energy wet scrubber is capable of efficiently removing particles greater than about 5-10 micrometers in diameter. A medium energy scrubber is capable of removing micrometer-sized particles, but is not very efficient on sub-micrometer particles. A high-energy scrubber is able to remove sub-micrometer particles.

A spray tower scrubber is a low energy scrubber and is the simplest wet scrubber used for particulate control. It consists of an open vessel with one or more sets of spray nozzles to distribute the scrubbing liquid. Typically, the gas stream enters at the bottom and passes upward through the sprays. The particles are collected when they impact the droplets. This is referred to as counter-current operation. Spray towers can also be operated in a cross-current arrangement. In cross-current scrubbers, the gas flow is horizontal and the liquid sprays flow downward. Cross-current spray towers are not usually as efficient as counter-current units.

The most common high energy wet scrubber is the venturi, although it can also be operated as a medium energy scrubber. In a fixed-throat venturi, the gas stream enters a converging section where it is accelerated toward the throat section. In the throat section, the high-velocity gas stream strikes liquid streams that are injected at right angles to the gas flow, shattering the liquid into small drops. The particles are collected when they impact the slower moving drops. Following the throat section, the gas stream passes through a diverging section that reduces the velocity.

All wet scrubber designs incorporate mist eliminators or entrainment separators to remove entrained droplets. The process of contacting the gas and liquid streams results in entrained droplets, which contain the contaminants or particulate matter. The most common mist eliminators are chevrons, mesh pads, and cyclones. Chevrons are simply zig-zag baffles that cause the gas stream to turn several times as it passes through the mist eliminator. The liquid droplets are collected on the blades of the chevron and drain back into the scrubber. Mesh pads are made from interlaced fibers that serve as the collection area. A cyclone is typically used for the small droplets generated in a venturi scrubber. The gas stream exiting the venturi enters the bottom of a vertical cylinder tangentially. The droplets are removed by centrifugal force as the gas stream spirals upward to the outlet.

2.7.5 Electrostatic Precipitator

An ESP is a control device designed to remove particulate matter (both PM_{10} and $PM_{2.5}$) from an exhaust gas stream. ESPs take advantage of the electrical principle that opposites attract. By imparting a high voltage charge to the particles, a high voltage direct current (DC) electrode negatively charges airborne particles in the exhaust stream, while simultaneously ionizing the carrier gas, producing an electrified field. The electric field in an ESP is the result of three contributing factors: the electrostatic component resulting from the application of a voltage in a dual electrode system, the component resulting from the space charge from the ions and free electrons, and the component resulting from the charged particulate. As the exhaust gas passes through this electrified field, the particles are charged. The strength or magnitude of the electric field is an indication of the effectiveness of an ESP. Typically, 20,000 to 70,000 volts are used. The particles, either negatively or positively charged, are attracted to the ESP collecting electrode of the opposite charge. When enough particulates have accumulated, the collectors are shaken to dislodge the dust, causing it to fall by gravity to hoppers below and then removed by a conveyor system for disposal or recycling. ESPs can handle large volumes of exhaust gases and because no filters are used, ESPs can handle hot gases from 350 ^{o}F to 1,300 ^{o}F.

2.7.6 SO_2 Reducing Catalysts

To help reduce condensable particulate matter formation from sulfur compounds, SOx reducing additives (catalysts) are used for reducing the production of SOx by-products in FCCUs. A SOx reducing catalyst is a metal oxide compound such as aluminum oxide (Al_2O_3), magnesium oxide (MgO), vanadium pentoxide (V_2O_5) or a combination of the three that is added to the FCCU catalyst as it circulates throughout the reactor. In the regenerator of the FCCU, sulfur bearing coke is burned and SO_2, CO, and CO_2 by-products are formed. A portion of SO_2 will react with excess oxygen and form SO_3, which will either stay in the flue gas or react with the metal oxide in the SOx reducing catalyst to form metal sulfate. In the FCCU reactor, the metal sulfate will react with hydrogen to form either metal sulfide and water, or more metal oxide. In the steam stripper section of the FCCU reactor, metal sulfide reacts with steam to form metal oxide and hydrogen sulfide (H_2S). The net effect of these reactions is that the quantity of SO_2 in the regenerator is typically reduced between 40 to 65 percent while the quantity of H_2S in the reactor is increased. Generally, the increase in H_2S is handled by sulfur recovery processes located elsewhere within a refinery.

2.7.7 Enhanced LDAR for Components in Heavy Liquid Service

Oil refineries, chemical plants, bulk plants, bulk terminals, and other facilities that store, transport and use organic liquids may occasionally have leaks wherever there is a connection between two pieces of equipment, and lose some organic material as fugitive ROG emissions. Valves, pumps, and compressors can also leak organic materials. The District Rule 8-18 requires such facilities to maintain LDAR programs. The rule originally required the monitoring of components in light hydrocarbon liquid service, but was expanded in 2015 to include equipment in heavy hydrocarbon liquid service. Those amendments have not been fully implemented due to litigation regarding uncertainty of heavy liquid fugitive emissions. The District is in the process of conducting studies to determine appropriate emission factors for heavy liquid leaks. Completion of the heavy liquid leak study has been problematic, because some heavy hydrocarbon liquids are condensing and coating the leak detection sensors. The study approach has been re-configured and the results are expected by Fall 2018. The results of the study will be used to determine appropriate revisions to Rule 8-18, e.g., types of monitoring instruments, frequency of monitoring, leak concentration limits, time allowed for repair of the leak, recordkeeping requirements, etc.

2.7.8 Selective Catalytic Reduction (SCR) at Petroleum Coke Calciners

SCR is post combustion control equipment for NOx control of combustion sources such as boilers and process heaters and is capable of reducing NOx emissions by as much as 95 percent or higher. A typical SCR system consists of an ammonia storage tank, ammonia vaporization and injection equipment, a booster fan for the flue gas exhaust, an SCR reactor with catalyst, and exhaust stack plus ancillary electronic instrumentation and operations control equipment. An SCR system reduces NOx by injecting a mixture of ammonia and air into the flue gas exhaust stream from the combustion equipment. This mixture flows into the SCR reactor where the catalyst, ammonia and oxygen in the flue gas exhaust reacts with NO and NO_2 to form nitrogen and water in the presence of the catalyst. The amount of ammonia introduced into the SCR system is approximately a one-to-one molar ratio of ammonia to NOx for optimum control efficiency, though the ratio may vary based on equipment-specific NOx reduction requirements. SCR catalysts are available in two types of solid, block configurations or modules, plate or honeycomb type, and are comprised of a base material of titanium dioxide that is coated with either tungsten trioxide, molybdic anhydride, vanadium pentoxide, iron oxide, or zeolite catalysts. These catalysts are used for SCRs because of their high activity, insensitivity to sulfur in the exhaust, and useful life span of five years or more. Ultimately, the material composition of the catalyst is dependent upon the application and flue gas conditions such as gas composition, temperature, etc. (SCAQMD, 2015).

For conventional SCRs, the minimum temperature for NOx reduction is 500^{o}F and the maximum operating temperature for the catalyst is 800 ^{o}F. The presence of particulates, heavy metals, sulfur compounds, and silica in the flue gas exhaust can limit catalyst performance. Minimizing the quantity of injected ammonia and maintaining the ammonia temperature within a predetermined range helps to avoid these undesirable reactions while minimizing the production of unreacted ammonia which is commonly referred to as "ammonia slip." Depending on the type of combustion equipment utilizing SCR, the typical amount of ammonia slip can vary between less than five ppmv when the catalyst is fresh and 20 ppmv at the end of the catalyst life.

2.7.9 LoTOx (wet scrubber) at Petroleum Coke Calciners

The LoTOx^{TM} is a registered trademark of Linde LLC (previously BOC Gases) and was later licensed to BELCO of Dupont for refinery applications. LoTOx^{TM} stands for "Low Temperature Oxidation" process in which ozone (O_3) is used to oxidize insoluble NOx compounds into soluble NOx compounds which can then be removed by absorption in a caustic, lime, or limestone solution. The LoTOx^{TM} process is a low temperature application, optimally operating at about 325 ^{o}F.

A typical combustion process produces about 95 percent NO and five percent NO_2. Because both NO and NO_2 are relatively insoluble in an aqueous solution, a WGS alone is not efficient in removing these insoluble compounds from the flue gas stream. However, with a LoTOx^{TM} system and the introduction of O_3, NO and NO_2 can be easily oxidized into a highly soluble compound N_2O_5 and subsequently converted to nitric acid (HNO_3). Then, in a wet gas scrubber for example, the HNO_3 is rapidly absorbed in caustic (NaOH), limestone or lime solution. The LoTOx^{TM} process can be integrated with any type of wet scrubbers (e.g., venturi, packed beds), semi-dry scrubbers, or wet ESPs. In addition, because the rates of oxidizing reactions for NOx are fast compared to the very slow SO_2 oxidation reaction, no ammonium bisulfate ($(NH_4)HSO_4$) or sulfur trioxide (SO_3) is formed (Confuorto and Sexton, 2007).

CHAPTER 3

ENVIRONMENTAL SETTING, IMPACTS, MITIGATION MEASURES, AND CUMULATIVE IMPACTS

Introduction
Air Quality
Hazards and Hazardous Materials
Hydrology and Water Quality
Growth Inducing Impacts
Significant Environmental Effects Which Cannot be Avoided
Environmental Effects Not Found to be Significant

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3.0 ENVIROMENTAL SETTING, IMPACTS, MITIGATION MEASURES AND CUMULATIVE IMPACTS

3.1 INTRODUCTION

This chapter of the Draft EIR describes the existing environmental setting in the Bay Area, analyzes the potential environmental impacts of the Expedited BARCT Implementation Schedule, and recommends mitigation measures (when significant environmental impacts have been identified). The chapter provides this analysis for each of the environmental areas identified in the Initial Study prepared by the Air District for the Expedited BARCT Implementation Schedule (BAAQMD, 2018) (see Appendix A). The Initial Study concluded that the approval of the Expedited BARCT Implementation Schedule could potentially result in significant environmental impacts to Air Quality, Hazards and Hazardous Materials, Hydrology and Water Quality, and Utilities and Service Systems. Water demand impacts were considered to be potentially significant in both the Hydrology and Water Quality, and Utilities and Service Systems section. The potential impacts on water demand were considered to be significant in both the Hydrology and Water Quality and Utilities Sections of the Initial Study. The impacts on water demand have been consolidated into the Hydrology and Water Quality section.

The potential impacts identified in the Initial Study will be evaluated in this EIR. Included for each impact category is a discussion of the: (1) Environmental Setting; (2) Regulatory Setting; (3) Significance Criteria; (4) Environmental Impacts; (5) Mitigation Measures (if necessary and available); and (6) Cumulative Impacts. A description of each subsection follows.

3.1.1 ENVIRONMENTAL SETTING

CEQA Guidelines §15360 (Public Resources Code Section 21060.5) defines "environment" as "the physical conditions that exist within the area which will be affected by a proposed project including land, air, water, minerals, flora, fauna, ambient noise, and objects of historical or aesthetic significance." CEQA Guidelines §15125(a) requires that an EIR include a description of the physical environmental conditions in the vicinity of the project, as they exist at the time the notice of preparation is published from both a local and regional perspective. This environmental setting will normally constitute the baseline physical conditions by which a lead agency determines whether an impact is significant. The description of the environmental setting is intended to be no longer than is necessary to gain an understanding of the significant effects of the proposed project and its alternatives.

This Chapter describes the existing environment in the Bay Area as it exists at the time the environmental analysis commenced (2018) to the extent that information is available. The analyses included in this chapter focus on those aspects of the environmental resource areas that could be adversely affected by the implementation of the proposed Expedited BARCT Schedule as determined in the NOP/IS (see Appendix A), and not those environmental resource areas determined to have no potential adverse impact from the proposed project.

The NOP/IS (see Appendix A) determined that impacts on Air Quality, Hazards and Hazardous Materials, and Hydrology and Water Quality (including water demand) associated with the proposed project were potentially significant and are evaluated in this EIR.

3.1.2 SIGNIFICANCE CRITERIA

This section identifies the criteria used to determine when physical changes to the environment created as a result of the proposed project approval would be considered significant. The levels of significance for each environmental resource were established by identifying significance criteria. These criteria are based upon those presented in the California Environmental Quality Act (CEQA) environmental checklist and the Air Districts CEQA Air Quality Guidelines (BAAQMD, 2017a).

The significance determination under each impact analysis is made by comparing the proposed project impacts with the conditions in the environmental setting and comparing the difference to the significance criteria.

3.1.3 ENVIRONMENTAL IMPACTS

The CEQA Guidelines also require the EIR to identify significant environmental effects that may result from a proposed project (CEQA Guidelines §15126.2(a)). Direct and indirect significant effects of a project on the environment must be identified and described, with consideration given to both short- and long-term impacts. The potential impacts associated with each resource are either quantitatively analyzed where possible or qualitatively analyzed where data are insufficient to quantify impacts. The impacts are compared to the significance criteria to determine the level of significance.

The impact sections of this chapter focus on those impacts that are considered potentially significant per the requirements of CEQA. An impact is considered significant if it leads to a "substantial, or potentially substantial, adverse change in the environment." Impacts from the project fall within one of the following categories:

> **Beneficial:** Impacts will have a positive effect on the resource.
>
> **No Impact:** There would be no impact to the identified resource as a result of the project.
>
> **Less than Significant:** Some impacts may result from the project; however, they are judged to be less than significant. Impacts are frequently considered less than significant when the changes are minor relative to the size of the available resource base or would not change an existing resource. A “less than significant impact” applies where the environmental impact does not exceed the significance threshold.

Potentially Significant but Mitigation Measures Can Reduce Impacts to Less Than Significant: Significant adverse impacts may occur; however, with proper mitigation, the impacts can be reduced to less than significant.

Potentially Significant or Significant Impacts: Adverse impacts may occur that would be significant even after mitigation measures have been applied to minimize their severity. A "potentially significant or significant impacts" applies where the environmental impact exceeds the significance threshold, or information was lacking to make a finding of insignificance.

It is important to note that CEQA may also apply to individual projects at the time any permits are submitted in the future in response to the regulation or regulations that may be approved by the Board and the potential for any control equipment or other design modifications to affected facilities to have secondary adverse environmental impacts will be evaluated at that time.

3.1.4 MITIGATION MEASURES

If significant adverse environmental impacts are identified, the CEQA Guidelines require a discussion of measures that could either avoid or substantially reduce any adverse environmental impacts to the greatest extent feasible (CEQA Guidelines §15126.4). The analyses in this chapter describe the potential for significant adverse impacts and identify mitigation measures where appropriate. This section describes feasible mitigation measures that could minimize potentially significant or significant impacts that may result from project approval. CEQA Guidelines (§15370) defines mitigation to include:

- Avoiding the impact altogether by not taking a certain action or parts of an action.

- Minimizing impacts by limiting the degree or magnitude of the action and its implementation.

- Rectifying the impact by repairing, rehabilitating or restoring the impacted environment.

- Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.

- Compensating for the impact by replacing or providing substitute resources or environments.

In accordance with CEQA statutes (§21081.6), a mitigation and monitoring program would be required to be adopted to demonstrate and monitor compliance with any mitigation measures identified in this EIR. The program would identify specific mitigation measures to be undertaken, when the measure would be implemented, and the agency responsible for oversight, implementation and enforcement.

3.1.5 CUMULATIVE IMPACTS

CEQA Guidelines §15130(a) requires an EIR to discuss cumulative impacts of a project when the project's incremental effect is cumulatively considerable. An EIR evaluating the environmental impact of air quality regulations essentially evaluates the cumulative impacts associated with a variety of regulatory activities. As such, this EIR evaluates the cumulative environmental impacts associated with implementation of other air quality regulations as outlined in the 2017 Clean Air Plan, the most recent air plan for the Bay Area (BAAQMD, 2017). The area evaluated for cumulative air impacts in this EIR is the area within the jurisdiction of the District, an area encompassing 5,600 square miles, which includes all of Alameda, Contra Costa, Marin, San Francisco, San Mateo, Santa Clara, and Napa Counties, and portions of southwestern Solano and southern Sonoma counties.

CHAPTER 3.2

AIR QUALITY IMPACTS

3.2 AIR QUALITY

This subchapter of the EIR evaluates the potential air quality impacts associated with implementation of the Expedited BARCT Implementation Schedule, which aims to reduce criteria pollutant emissions from industrial sources that currently participate in the GHG Cap-and-Trade system.

As discussed in the Initial Study, in accordance with AB 617, the purpose of the Expedited BARCT Implementation Schedule is to implement several rule development projects that utilize BARCT to reduce criteria pollutant emissions from sources participating in the GHG Cap-and-Trade system in the Bay Area. However, certain control measures have the potential to increase emissions of other pollutants, such as GHGs and criteria pollutants. Adverse impacts include increased emissions associated with construction activities and combustion sources from certain types of air pollution control equipment. The NOP/IS (see Appendix A) determined that air quality impacts of the proposed project are potentially significant. Project-specific and cumulative adverse air quality impacts associated with the proposed rule amendments have been evaluated in Chapter 3.2.6 of this EIR.

3.2.1 ENVIRONMENTAL SETTING

3.2.1.1 Criteria Pollutants

<u>Ambient Air Quality Standards</u>

It is the responsibility of the Air District to ensure that state and federal ambient air quality standards (AAQS) are achieved and maintained in its geographical jurisdiction. Health-based air quality standards have been established by California and the federal government for the following criteria air pollutants: ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), particulate matter (PM_{10} and $PM_{2.5}$), sulfur dioxide (SO_2), and lead (Pb). These standards were established to protect sensitive receptors with a margin of safety from adverse health impacts due to exposure to air pollution. California has also established standards for sulfate, visibility, hydrogen sulfide, and vinyl chloride. The state and national NAAQS for each of these pollutants and their effects on health are summarized in Table 3.2-1.

TABLE 3.2-1

Federal and State Ambient Air Quality Standards

	STATE STANDARD	FEDERAL PRIMARY STANDARD	MOST RELEVANT EFFECTS
AIR POLLUTANT	CONCENTRATION/ AVERAGING TIME	CONCENTRATION/ AVERAGING TIME	
Ozone	0.09 ppm, 1-hr. avg. > 0.070 ppm, 8-hr	No Federal 1-hr standard 0.070 ppm, 8-hr avg. >	(a) Short-term exposures: (1) Pulmonary function decrements and localized lung edema in humans and animals (2) Risk to public health implied by alterations in pulmonary morphology and host defense in animals; (b) Long-term exposures: Risk to public health implied by altered connective tissue metabolism and altered pulmonary morphology in animals after long-term exposures and pulmonary function decrements in chronically exposed humans; (c) Vegetation damage; (d) Property damage
Carbon Monoxide	9.0 ppm, 8-hr avg. > 20 ppm, 1-hr avg. >	9 ppm, 8-hr avg.> 35 ppm, 1-hr avg.>	(a) Aggravation of angina pectoris and other aspects of coronary heart disease; (b) Decreased exercise tolerance in persons with peripheral vascular disease and lung disease; (c) Impairment of central nervous system functions; (d) Possible increased risk to fetuses
Nitrogen Dioxide	0.030 ppm, annual avg. 0.18 ppm, 1-hr avg. >	0.053 ppm, ann. avg.> 0.100 ppm, 1-hr avg.	(a) Potential to aggravate chronic respiratory disease and respiratory symptoms in sensitive groups; (b) Risk to public health implied by pulmonary and extra-pulmonary biochemical and cellular changes and pulmonary structural changes; (c) Contribution to atmospheric discoloration
Sulfur Dioxide	0.04 ppm, 24-hr avg.> 0.25 ppm, 1-hr. avg. >	No Federal 24-hr Standard> 0.075 ppm, 1-hr avg.>	(a) Bronchoconstriction accompanied by symptoms which may include wheezing, shortness of breath and chest tightness, during exercise or physical activity in persons with asthma
Suspended Particulate Matter (PM_{10})	20 µg/m^3, ann. arithmetic mean > 50 µg/m^3, 24-hr average>	No Federal annual Standard 150 µg/m^3, 24-hr avg.>	(a) Excess deaths from short-term exposures and exacerbation of symptoms in sensitive patients with respiratory disease; (b) Excess seasonal declines in pulmonary function, especially in children
Suspended Particulate Matter ($PM_{2.5}$)	12 µg/m^3, annual arithmetic mean> No State 24-hr Standard	12 µg/m^3, annual arithmetic mean> 35 µg/m^3, 24-hour average>	Decreased lung function from exposures and exacerbation of symptoms in sensitive patients with respiratory disease; elderly; children.
Sulfates	25 µg/m^3, 24-hr avg. >=	No Federal Standard	(a) Decrease in ventilatory function; (b) Aggravation of asthmatic symptoms; (c) Aggravation of cardio-pulmonary disease; (d) Vegetation damage; (e) Degradation of visibility; (f) Property damage
Lead	1.5 µg/m^3, 30-day avg. >= No State Calendar Quarter Standard No State 3-Month Rolling Avg. Standard	No Federal 30-day avg. Standard 1.5 µg/m^3, calendar quarter> 0.15 µg/m^3 3-Month Rolling average	(a) Increased body burden; (b) Impairment of blood formation and nerve conduction
Visibility-Reducing Particles	In sufficient amount to give an extinction coefficient >0.23 inverse kilometers (visual range to less than 10 miles) with relative humidity less than 70%, 8-hour average (10am – 6pm PST)	No Federal Standard	Visibility based standard, not a health based standard. Nephelometry and AISI Tape Sampler; instrumental measurement on days when relative humidity is less than 70 percent

U.S. EPA requires CARB and Air Districts to measure the ambient levels of air pollution to determine compliance with the NAAQS. To comply with this mandate, the Air District monitors levels of various criteria pollutants at 25 monitoring stations within the San Francisco Bay Area. A summary of the 2017 maximum concentration and number of days exceeding state and federal ambient air standards at the Air District monitoring stations are presented in Table 3.2-2.

TABLE 3.2-2
Bay Area Air Pollution Summary – 2017

MONITORING STATIONS	OZONE						CARBON MONOXIDE			NITROGEN DIOXIDE				SULFUR DIOXIDE				PM_{10}				$PM_{2.5}$				
	Max 1-Hr	Cal 1-Hr Days	Max 8-Hr	Nat 8-Hr Days	Cal 8-Hr Days	3-Yr Avg	Max 1-Hr	Max 8-Hr	Nat/ Cal Days	Max 1-Hr	Ann Avg	Nat 1-Hr Days	Cal 1-Hr Days	Max 1-Hr	Max 24-Hr	Nat 1-Hr Days	Cal 24-Hr Days	Ann Avg	Max 24-Hr	Nat 24-Hr Days	Cal 24-Hr Days	Max 24-Hr	Nat 24-Hr Days	3-Yr Avg	Ann Avg	3-Yr Avg
North Counties	(ppb)						(ppm)			(ppb)				(ppb)				(µg/m³)				(µg/m³)				
Napa	98	1	84	2	2	63	5.6	4.7	0	53	7	0	0	-	-	-	-	-	-	-	-	199.1	13	35	13.7	10.9
San Rafael	88	0	63	0	0	58	2.6	1.6	0	53	10	0	0	-	-	-	-	17.7	94	0	2	74.7	8	27	9.7	8.2
Sebastopol	87	0	71	1	1	53	2.1	1.6	0	35	5	0	0	-	-	-	-	-	-	-	-	81.8	4	21	8.1	6.5
Vallejo	105	1	88	2	2	61	3.1	2.1	0	49	8	0	0	5.9	2.17	0	0	-	-	-	-	101.9	9	30	11.6	9.5
Coast/Central Bay																										
Berkeley Aquatic Pk*	58	0	49	0	0	*	2.2	1.7	0	123	16	1	0	-	-	-	-	-	-	-	-	52.0	7	*	9.1	*
Laney College Fwy	-	-	-	-	-	-	1.9	1.3	0	68	17	0	0	-	-	-	-	-	-	-	-	70.8	8	27	11.6	10.1
Oakland	136	2	100	2	2	54	3.2	2.2	0	65	10	0	0	-	-	-	-	-	-	-	-	70.2	7	24	9.4	7.9
Oakland-West	87	0	68	0	0	48	6.0	2.1	0	52	13	0	0	16.9	2.2	0	0	-	-	-	-	56.0	7	28	12.8	10.6
Richmond	-	-	-	-	-	-	-	-	-	-	-	-		16.0	2.9	0	0	-	-	-	-	-	-	-	-	-
San Francisco	87	0	54	0	0	47	2.5	1.4	0	73	11	0	0	-	-	-	-	22.0	77	0	2	49.9	7	27	9.7	8.3
San Pablo	104	3	80	2	2	52	2.5	1.9	0	48	8	0	0	8.3	2.7	0	0	20.3	95	0	4	71.2	9	30	10.8	9.3
Eastern District																										
Bethel Island	90	0	71	1	2	68	1.6	1.0	0	34	5	0	0	5.3	3.5	0	0	16.3	52	0	1	-	-	-	-	-
Concord	82	0	70	0	0	66	1.7	1.3	0	41	7	0	0	13.2	2.6	0	0	13.3	41	0	0	89.4	6	26	12.0	8.9
Crockett	-	-	-	-	-	-	-	-	-	-	-	-	-	23.5	5.6	0	0	-	-	-	-	-	-	-	-	-
Fairfield	80	0	62	0	0	63	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Livermore	109	5	86	6	6	75	-	-	-	45	9	0	0	-	-	-	-	-	-	-	-	41.5	2	25	8.5	8.2
Martinez	-	-	-	-	-	-	-	-	-	-	-	-	-	15.9	3.1	0	0	-	-	-	-	-	-	-	-	-
San Ramon	92	0	75	2	2	68	-	-	-	31	5	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-
South Central Bay																										
Hayward	139	2	110	3	4	65	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Redwood City	115	2	86	2	2	56	2.8	1.4	0	67	11	0	0	-	-	-	-	-	-	-	-	60.8	6	23	9.1	7.7
Santa Clara Valley																										
Gilroy	96	1	84	1	1	64	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	48.4	2	18	75.5	6.1
Los Gatos	93	0	75	3	3	66	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
San Jose	121	3	98	4	4	67	2.1	1.8	0	68	12	0	0	3.6	1.1	0	0	21.6	70	0	6	49.7	6	27	9.5	9.3
San Jose Freeway	-	-	-	-	-	-	2.6	1.8	0	77	17	0	0	-	-	-	-	-	-	-	-	48.4	8	28	10.8	9.5
San Martin	96	1	86	3	3	69	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-
Total Days over Standard		**6**		**6**	**6**				**0**			**1**	**0**			**0**	**0**			**0**	**6**		**18**			

Source: BAAQMD, 2018.
*Near-road air monitoring at Berkeley Aquatic Park began on July 1,2016. Therefore, 3-year average statistics for ozone and $PM_{2.5}$ are not available.
(ppb) = parts per billion (ppm) = parts per million, (µg/m³) = micrograms per cubic meter
.

Air quality conditions in the San Francisco Bay Area have improved since the Air District was created in 1955. The long-term trend of ambient concentrations of air pollutants and the number of days on which the region exceeds (AAQS) have generally declined, although some year-to-year variability primarily due to meteorology, causes some short-term increases in the number of exceedance days (see Table 3.2-3). The Air District is in attainment of the State AAQS for CO, NO_2, and SO_2. However, the Air District does not comply with the State 24-hour PM_{10} standard, annual PM_{10} standard, and annual $PM_{2.5}$ standard. The Air District is unclassifiable/attainment for the federal CO, NO_2, SO_2, Pb, and PM_{10} standards. A designation of unclassifiable/attainment means that the U.S. EPA has determined to have sufficient evidence to find the area either is attaining or is likely attaining the NAAQS.

The 2017 air quality data from the Air District monitoring stations are presented in Table 3.2-2. No monitoring stations measured an exceedance of any of State or federal AAQS for CO and SO_2. There was one exceedance of the federal NO_2 AAQS at one monitoring station in 2017, although the area did not violate the NAAQS. All monitoring stations were in compliance with the federal PM_{10} standards. The State 24-hour PM_{10} standard was exceeded on six days in 2017, at the San Jose monitoring station (see Table 3.2-2).

The Bay Area is designated as a non-attainment area for the federal and state 8-hour ozone standard and the federal 24-hour $PM_{2.5}$ standard. The state and federal 8-hour ozone standards were exceeded on 6 days in 2017 at one site or more in the Air District; most frequently in the Eastern District (Livermore, Patterson Pass, and San Ramon) and the Santa Clara Valley (see Table 3.2-2). The federal 24-hour $PM_{2.5}$ standard was exceeded at one or more Bay Area station on 18 days in 2017, most frequently in the Napa, San Rafael, Vallejo, and San Pablo.

TABLE 3.2-3

Bay Area Air Quality Summary
Days over Standards

YEAR	OZONE			CARBON MONOXIDE				NOx		SULFUR DIOXIDE		PM_{10}		$PM_{2.5}$
	8-Hr	1-Hr	8-Hr	1-Hr		8-Hr		1-Hr		1-Hr	24-Hr	24-Hr*		24-Hr
	Nat	Cal	Cal	Nat	Cal	Nat	Cal	Nat	Cal	Nat	Cal	Nat	Cal	Nat
2008	19	9	20	0	0	0	0	0	0	2	0	0	5	12
2009	11	11	13	0	0	0	0	0	0	0	0	0	1	11
2010	11	8	11	0	0	0	0	0	0	0	0	0	2	6
2011	9	5	10	0	0	0	0	0	0	0	0	0	3	8
2012	8	3	8	0	0	0	0	1	0	0	0	0	2	3
2013	3	3	3	0	0	0	0	0	0	0	0	0	6	13
2014	9	3	10	0	0	0	0	0	0	0	0	0	2	3
2015	12	7	12	0	0	0	0	0	0	0	0	0	1	9
2016	15	6	15	0	0	0	0	0	0	0	0	0	0	0
2017	6	6	6	0	0	0	0	1	0	0	0	0	6	18

Source: BAAQMD, 2018

3.2.1.2 Criteria Pollutant Health Effects

3.2.1.2.1 Ozone

Ozone is not emitted directly from pollution sources. Instead ozone is formed in the atmosphere through complex chemical reactions between hydrocarbons, or reactive organic gases (ROG, also commonly referred to as reactive organic gases (ROG), and nitrogen oxides (NOx), in the presence of sunlight. ROG and NOx are referred to as ozone precursors.

Ozone, a colorless gas with a sharp odor, is a highly reactive form of oxygen. High ozone concentrations exist naturally in the stratosphere. Some mixing of stratospheric ozone downward through the troposphere to the earth's surface does occur; however, the extent of ozone mixing is limited. At the earth's surface in sites remote from urban areas ozone concentrations are normally very low (0.03-0.05 ppm). While ozone is beneficial in the stratosphere because it filters out skin-cancer-causing ultraviolet radiation, ground level ozone is harmful, is a highly reactive oxidant, which accounts for its damaging effects on human health, plants and materials at the earth's surface.

Ozone is harmful to public health at high concentrations near ground level. Ozone can damage the tissues of the lungs and respiratory tract. High concentrations of ozone irritate the nose, throat, and respiratory system and constrict the airways. Ozone also can aggravate other respiratory conditions such as asthma, bronchitis, and emphysema, causing increased hospital admissions. Repeated exposure to high ozone levels can make people more susceptible to respiratory infection and lung inflammation and permanently damage lung tissue. Ozone can also have negative cardiovascular impacts, including chronic hardening of the arteries and acute triggering of heart attacks. Children are most at risk as they tend to be active and outdoors in the summer when ozone levels are highest. Seniors and people with respiratory illnesses are also especially sensitive to ozone’s effects. Even healthy adults can be affected by working or exercising outdoors during high ozone levels.

The propensity of ozone for reacting with organic materials causes it to be damaging to living cells, and ambient ozone concentrations in the Bay Area are occasionally sufficient to cause health effects. Ozone enters the human body primarily through the respiratory tract and causes respiratory irritation and discomfort, makes breathing more difficult during exercise, reducing the respiratory system's ability to remove inhaled particles and fight infection while long-term exposure damages lung tissue. People with respiratory diseases, children, the elderly, and people who exercise heavily are more susceptible to the effects of ozone.

Plants are sensitive to ozone at concentrations well below the health-based standards and ozone is responsible for significant crop damage. Ozone is also responsible for damage to forests and other ecosystems.

3.2.1.2.2 Reactive Organic Gases (ROGs)

It should be noted that there are no state or national ambient air quality standards for ROGs because they are not classified as criteria pollutants. ROGs are regulated, however, because ROG emissions contribute to the formation of ozone. They are also transformed into organic aerosols in the atmosphere, contributing to higher PM_{10} and lower visibility levels.

Although health-based standards have not been established for ROGs, health effects can occur from exposures to high concentrations of ROGs because of interference with oxygen uptake. In general, ambient ROG concentrations in the atmosphere are suspected to cause coughing, sneezing, headaches, weakness, laryngitis, and bronchitis, even at low concentrations. Some hydrocarbon components classified as ROG emissions are thought or known to be hazardous. Benzene, for example, one hydrocarbon component of ROG emissions, is known to be a human carcinogen.

ROG emissions result primarily from incomplete fuel combustion and the evaporation of paints, solvents and fuels. Mobile sources are the largest contributors to ROG emissions. Stationary sources include processes that use solvents (such as manufacturing, degreasing, and coating operations) and petroleum refining, and marketing. Area-wide ROG sources include consumer products, pesticides, aerosol and architectural coatings, asphalt paving and roofing, and other evaporative emissions.

3.2.1.2.3 Carbon Monoxide (CO)

CO is a colorless, odorless, relatively inert gas. It is a trace constituent in the unpolluted troposphere, and is produced by both natural processes and human activities. In remote areas far from human habitation, carbon monoxide occurs in the atmosphere at an average background concentration of 0.04 ppm, primarily as a result of natural processes such as forest fires and the oxidation of methane. Global atmospheric mixing of CO from urban and industrial sources creates higher background concentrations (up to 0.20 ppm) near urban areas. The major source of CO in urban areas is incomplete combustion of carbon-containing fuels, mainly gasoline used in mobile sources. Consequently, CO concentrations are generally highest in the vicinity of major concentrations of vehicular traffic.

CO is a primary pollutant, meaning that it is directly emitted into the air, not formed in the atmosphere by chemical reaction of precursors, as is the case with ozone and other secondary pollutants. Ambient concentrations of CO in the District exhibit large spatial and temporal variations, due to variations in the rate at which CO is emitted, and in the meteorological conditions that govern transport and dilution. Unlike ozone, CO tends to reach high concentrations in the fall and winter months. The highest concentrations frequently occur on weekdays at times consistent with rush hour traffic and late night during the coolest, most stable atmospheric portion of the day.

When CO is inhaled in sufficient concentration, it can displace oxygen and bind with the hemoglobin in the blood, reducing the capacity of the blood to carry oxygen. Individuals most at risk from the effects of CO include heart patients, fetuses (unborn babies), smokers, and people who exercise heavily. Normal healthy individuals are affected at higher concentrations, which may cause impairment of manual dexterity, vision, learning ability, and performance of work. The results of studies concerning the combined effects of CO and other pollutants in animals have shown a synergistic effect after exposure to CO and ozone.

3.2.1.2.4 Particulate Matter (PM_{10} & $PM_{2.5}$)

Particulate matter, or PM, consists of microscopically small solid particles or liquid droplets suspended in the air. PM can be emitted directly into the air or it can be formed from secondary reactions involving gaseous pollutants that combine in the atmosphere. Particulate pollution is primarily a problem in winter, accumulating when cold, stagnant weather comes into the Bay Area. PM is usually broken down further into two size distributions, PM_{10} and $PM_{2.5}$. Of great concern to public health are the particles small enough to be inhaled into the deepest parts of the lung. Respirable particles (particulate matter less than about 10 micrometers in diameter) can accumulate in the respiratory system and aggravate health problems such as asthma, bronchitis and other lung diseases. Children, the elderly, exercising adults, and those suffering from asthma are especially vulnerable to adverse health effects of PM_{10} and $PM_{2.5}$.

A consistent correlation between elevated ambient particulate matter (PM_{10} and $PM_{2.5}$) levels and an increase in mortality rates, respiratory infections, number and severity of asthma attacks and the number of hospital admissions has been observed in different parts of the United States and various areas around the world. Studies have reported an association between long-term exposure to air pollution dominated by fine particles ($PM_{2.5}$) and increased mortality, reduction in life-span, and an increased mortality from lung cancer.

Daily fluctuations in fine particulate matter concentration levels have also been related to hospital admissions for acute respiratory conditions, to school and kindergarten absences, to a decrease in respiratory function in normal children and to increased medication use in children and adults with asthma. Studies have also shown lung function growth in children is reduced with long-term exposure to particulate matter. The elderly, people with pre-existing respiratory and/or cardiovascular disease and children appear to be more susceptible to the effects of PM_{10} and $PM_{2.5}$.

3.2.1.2.5 Nitrogen Dioxide (NO_2)

NO_2 is a reddish-brown gas with a bleach-like odor. Nitric oxide (NO) is a colorless gas, formed from the nitrogen (N_2) and oxygen (O_2) in air under conditions of high temperature and pressure which are generally present during combustion of fuels; NO reacts rapidly with the oxygen in air to form NO_2. NO_2 is responsible for the brownish tinge of polluted air. The two gases, NO and NO_2, are referred to collectively as nitrogen oxides or NOx.

In the presence of sunlight, NO_2 reacts to form nitric oxide and an oxygen atom. The oxygen atom can react further to form ozone, via a complex series of chemical reactions involving hydrocarbons. Nitrogen dioxide may also react to form nitric acid (HNO_3) which reacts further to form nitrates, which are a component of PM_{10}.

NO_2 is a respiratory irritant and reduces resistance to respiratory infection. Children and people with respiratory disease are most susceptible to its effects.

3.2.1.2.6 Sulfur Dioxide (SO_2)

SO_2 is a colorless gas with a sharp odor. It reacts in the air to form sulfuric acid (H_2SO_4), which contributes to acid precipitation, and sulfates, which are a component of PM_{10} and $PM_{2.5}$. Most of the SO_2 emitted into the atmosphere is produced by the burning of sulfur-containing fuels.

At sufficiently high concentrations, SO_2 affects breathing and the lungs' defenses, and can aggravate respiratory and cardiovascular diseases. Asthmatics and people with chronic lung disease or cardiovascular disease are most sensitive to its effects. SO_2 also causes plant damage, damage to materials, and acidification of lakes and streams.

3.2.1.3 Current Emissions Inventory

An emission inventory is a detailed estimate of air pollutant emissions from a range of sources in a given area, for a specified time period. Future projected emissions incorporate current levels of control on sources, growth in activity in the Air District and implementation of future programs that affect emissions of air pollutants.

3.2.1.3.1 Ozone

NOx and ROG emissions are decreasing state-wide and in the San Francisco Bay Area since 1975 and are projected to continue to decline. ROG emissions result primarily from incomplete fuel combustion and the evaporation of paints, solvents and fuels. Mobile sources are the largest contributors to ROG emissions. Stationary sources include processes that use solvents (such as manufacturing, degreasing, and coating operations) and petroleum refining and marketing. Area-wide ROG sources include consumer products, pesticides, aerosol and architectural coatings, asphalt paving and roofing, and other evaporative emissions. About 42 percent of anthropogenic ROG emissions in the Bay Area are from mobile source emissions, while 26 percent are from petroleum and solvent evaporation (see Table 3.2-4) (BAAQMD, 2017).

TABLE 3.2-4

Anthropogenic Air Emission Inventory 2015
(tons per day)

Source	ROG	NOx
On-Road Motor Vehicles	59.6	128.1
Other Mobile Sources	49.2	122.2
Petroleum & Solvent Evaporation	67.3	--
Industrial and Commercial	15.4	3.0
Combustion	13.0	44.7
Other Sources	54.4	1.2

Source: BAAQMD, 2017

Approximately 84 percent of NOx emissions in the Bay Area are produced by the combustion of fuels. Mobile sources of NOx include motor vehicles, aircraft, trains, ships, recreation boats, industrial and construction equipment, farm equipment, off-road recreational vehicles, and other equipment. NOx and ROG emissions have been reduced for both stationary and mobile sources due to more stringent regulations from CARB and the District, respectively (see Table 3.2-4) (BAAQMD, 2017).

3.2.1.3.2 Particulate Matter

Particulate matter (both PM_{10} and $PM_{2.5}$) is a diverse mixture of suspended particles and liquid droplets (aerosols). PM includes elements such as carbon and metals; compounds such as nitrates, organics, and sulfates; and complex mixtures such as diesel exhaust, wood smoke, and soil. Unlike the other criteria pollutants which are individual chemical compounds, PM includes all particles that are suspended in the air. PM is both directly emitted (referred to as direct PM or primary PM) and also formed in the atmosphere through reactions among different pollutants (this is referred to as indirect or secondary PM).

PM is generally characterized on the basis of particle size. Ultra-fine PM includes particles less than 0.1 microns in diameter. Fine PM ($PM_{2.5}$) consists of particles 2.5 microns or less in diameter. PM_{10} consists of particles 10 microns or less in diameter. Total suspended particulates (TSP) includes suspended particles of any size.

Combustion of fossil fuels and biomass, primarily wood, from various sources are the primary contributors of directly-emitted Bay Area $PM_{2.5}$ (BAAQMD, 2017). Biomass combustion concentrations are about 3-4 times higher in winter than during the other seasons, and its contribution to peak $PM_{2.5}$ is greater. The increased winter biomass combustion sources reflect increased residential wood-burning during the winter season. The inventory of PM_{10} and $PM_{2.5}$ emission sources is provided in Table 3.2-5.

TABLE 3.2-5

Particulate Emissions Inventory by Source, Annual Average 2015 (tons per day)

Source	PM_{10}	$PM_{2.5}$
Residential Wood-Burning	12.0	11.8
Geological Dust	49.1	6.6
On-Road Motor Vehicles	12.0	5.6
Other Mobile Sources	5.5	5.6
Industrial Combustion	6.5	6.1
Industrial/Commercial Processes	7.6	4.7
Accidental Fires	4.4	3.8
Commercial Cooking	2.2	1.9
Animal Waste	9.8	0.9

Source: BAAQMD, 2017

3.2.1.4 Non-Criteria Pollutants Health Effects

Although the primary mandate of the Air District is attaining and maintaining the national and state Ambient Air Quality Standards for criteria pollutants within the Air District jurisdiction, the Air District also has a general responsibility to control, and where possible, reduce public exposure to airborne toxic compounds. TACs are a defined set of airborne pollutants that may pose a present or potential hazard to human health. TACs can be emitted directly and can also be formed in the atmosphere through reactions among different pollutants. The health effects associated with TACs are quite diverse and generally are assessed locally, rather than regionally. TACs can cause long-term health effects such as cancer, birth defects, neurological damage, asthma, bronchitis or genetic damage; or short-term acute affects such as eye watering, respiratory irritation, running nose, throat pain, and headaches. TACs are separated into carcinogens and non-carcinogens based on the nature of the pollutant. Carcinogens are assumed to have no safe threshold below which health impacts would not occur. Non-carcinogenic substances differ in that there is generally assumed to be a safe level of exposure below which no negative health impact is expected to occur. These levels are determined on a pollutant-by-pollutant basis. The air toxics program was established as a separate and complementary program designed to evaluate and reduce adverse health effects resulting from exposure to TACs.

The major elements of the District's air toxics program are outlined below.

- Preconstruction review of new and modified sources for potential health impacts, and the requirement for new/modified sources with TAC emissions that exceed a specified threshold to use BACT.

- The Air Toxics Hot Spots Program, designed to identify industrial and commercial facilities that may result in locally elevated ambient concentrations of TACs, to report significant emissions to the affected public, and to reduce unacceptable health risks.

- The District's Community Air Risk Evaluation (CARE) Program has been implemented to identify areas where air pollution contributes most to health impacts and where populations are most vulnerable to air pollution; to reduce the health impacts in these areas; and to engage the community and other agencies to develop additional actions to reduce local health impacts.

- Control measures designed to reduce emissions from source categories of TACs, including rules originating from the state Toxic Air Contaminant Act and the federal Clean Air Act.

- The TAC emissions inventory, a database that contains information concerning routine and predictable emissions of TACs from permitted stationary sources.

- Ambient monitoring of TAC concentrations at a number of sites throughout the Bay Area.

- The District's Regulation 11, Rule 18: Reduction from Air Toxic Emissions at Existing Facilities which was adopted November 15, 2017. This rule requires the District to conduct screening analyses for facilities that report TAC emissions within the District and calculate health prioritization scores based on the amount of TAC emissions, the toxicity of the TAC pollutants, and the proximity of the facilities to local communities. The District will conduct health risk assessments for facilities that have priority scores above a certain level. Based on the health risk assessment, facilities found to have a potential health risk above the risk action level would be required to reduce their risk below the action level, or install Best Available Retrofit Control Technology for Toxics on all significant sources of toxic emissions.

3.2.1.4.1 TAC Health Effects

TACs can cause or contribute to a wide range of health effects. Acute (short-term) health effects may include eye and throat irritation. Chronic (long-term) exposure to TACs may cause more severe effects such as neurological damage, hormone disruption, developmental defects, and cancer. CARB has identified roughly 200 TACs, including diesel particulate matter (diesel PM) and environmental tobacco smoke.

Unlike criteria pollutants which are subject to ambient air quality standards, TACs are primarily regulated at the individual emissions source level based on risk assessment. Human outdoor exposure risk associated with an individual air toxic species is calculated as its ground-level concentration multiplied by an established unit risk factor for that air toxic species. Total risk due to TACs is the sum of the individual risks associated with each air toxic species.

Occupational health studies have shown diesel PM to be a lung carcinogen as well as a respiratory irritant. Benzene, present in gasoline vapors and also a byproduct of combustion, has been classified as a human carcinogen and is associated with leukemia. 1,3-butadiene, produced from motor vehicle exhaust and other combustion sources, has also been associated with leukemia. Reducing 1,3-butadiene also has a co-benefit in reducing the air toxic acrolein.

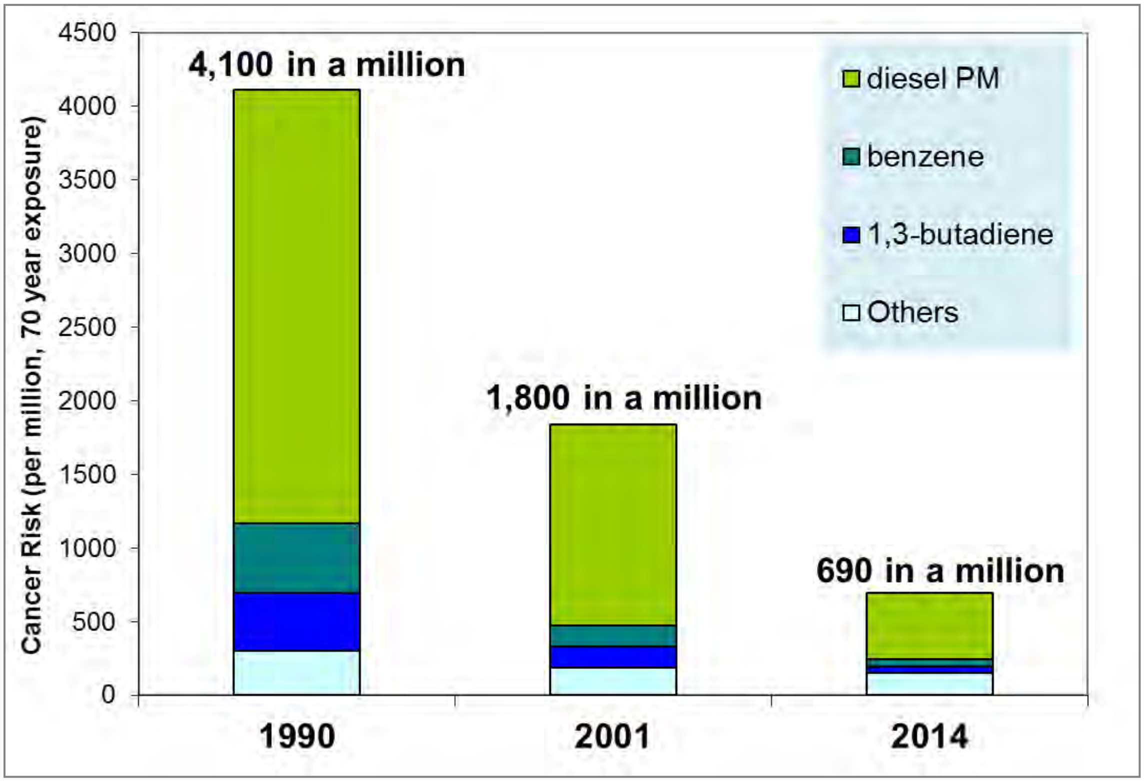
Acetaldehyde and formaldehyde are emitted from fuel combustion and other sources. They are also formed photo-chemically in the atmosphere from other compounds. Both compounds have been found to cause nasal cancers in animal studies and are also associated with skin and respiratory irritation. Human studies for carcinogenic effects of acetaldehyde are sparse but, in combination with animals studies, sufficient to support classification as a probable human carcinogen. Formaldehyde has been associated with nasal sinus cancer and nasopharyngeal cancer, and possibly with leukemia.

The primary health risk of concern due to exposure to TACs is the risk of contracting cancer. The carcinogenic potential of TACs is a particular public health concern because many scientists currently believe that there are not "safe" levels of exposure to carcinogens without some risk to causing cancer. The proportion of cancer deaths attributable to air pollution has not been estimated using epidemiological methods. Based on ambient air quality monitoring, and using OEHHA cancer risk factors,[1] the estimated lifetime cancer risk for Bay Area residents, over a 70-year lifespan from all TACs combined, declined from 4,100 cases per million in 1990 to 690 cases per million people in 2014, as shown in Figure 3.2-1. This represents an 80 percent decrease between 1990 and 2014 (BAAQMD, 2016).

The cancer risk related to diesel PM, which accounts for most of the cancer risk from TACs, has declined substantially over the past 15-20 years as a result of ARB regulations and Air District programs to reduce emissions from diesel engines. However, diesel PM still accounts for roughly 60 percent of the total cancer risk related to TACs.

[1] See CARB's Risk Management Guidance for Stationary Sources of Air Toxics, Discussion Draft, May 27, 2015, https://www.arb.ca.gov/toxics/rma/rma_guidancedraft052715.pdf and the Office Environmental Health Hazard Assessment's toxicity values at http://oehha.ca.gov/media/CPFs042909.pdf. The cancer risk estimates shown in Figure 3.2-1 are higher than the estimates provided in documents such as the Bay Area 2010 Clean Air Plan and the April 2014 CARE report entitled *Improving Air Quality and Health in Bay Area Communities*. It should be emphasized that the higher risk estimates shown in Figure 3.2-1 are due solely to changes in the methodology used to estimate cancer risk, and not to any actual increase in TAC emissions or population exposure to TACs.

FIGURE 3.2-1 Cancer-Risk Weighted Toxics Trends



Source: BAAQMD, 2016

3.2.1.4.2 Air Toxics Emission Inventory

The Air District maintains a database that contains information concerning emissions of TACs from permitted stationary sources in the Bay Area. This inventory, and a similar inventory for mobile and area sources compiled by CARB, is used to plan strategies to reduce public exposure to TACs. The detailed emissions inventory is reported in the Air District Toxic Air Contaminant Control Program, 2010 Annual Report (BAAQMD, 2015). The 2010 emissions inventory continues to show decreasing emissions of many TACs in the Bay Area.

3.2.1.4.3 Ambient Monitoring Network

Table 3.2-6 contains a summary of average ambient concentrations of TACs measured at monitoring stations in the Bay Area by the District in 2017.

TABLE 3.2-6

Summary of 2017 Air District Ambient Air Toxics Monitoring Data

Compound	Max. Conc. (ppb) (1)	Min. Conc. (ppb) (2)	Mean Conc. (ppb) (3)
1,3-Butadiene	0.541	0.000	0.012
Acetaldehyde	5.680	0.480	1.982
Acetone	29.901	0.345	4.072
Acetonitrile	3.799	0.000	0.088
Acyrlonitrile	0.323	0.000	0.001
Benzene	3.123	0.000	0.221
Carbon Tetrachloride	0.130	0.024	0.098
Chloroform	0.115	0.000	0.023
Dichloromethane	1.791	0.000	0.159
Ethyl Alcohol	91.740	0.236	5.455
Ethylbenzene	1.136	0.000	0.138
Ethylene Dibromide	0.000	0.000	0.000
Ethylene Dichloride	0.000	0.000	0.000
Formaldehyde	7.290	0.480	2.707
Freon-113	0.205	0.051	0.070
Methyl Chloroform	1.226	0.000	0.006
Methyl Ethyl Ketone	5.743	0.000	0.259
Tetrachloroethylene	0.337	0.000	0.003
Toluene	3.925	0.000	0.503
Trichloroethylene	0.328	0.000	0.001
Trichlorofluoromethane	0.593	0.194	0.248
Vinyl Chloride	0.000	0.000	0.000
m/p-Xylene	2.929	0.000	0.236
o-Xylene	1.446	0.000	0.108

Source: BAAQMD, 2018a

NOTES: Table 3.2-6 summarizes the results of the Air District gaseous toxic air contaminant monitoring network for the year 2017. These data represent monitoring results at 21 separate sites at which samples were collected.

(1) "Maximum Conc." is the highest daily concentration measured at any of the 21 monitoring sites.

(2) "Minimum Conc." is the lowest daily concentration measured at any of the 21 monitoring sites.

(3) "Mean Conc." is the arithmetic average of the air samples collected in 2017 at the 21 monitoring sites.

(4) Acetaldehyde and formaldehyde concentrations reflect measurements from one monitoring site (San Jose-Jackson).

3.2.2 REGULATORY SETTING

3.2.2.1 Criteria Pollutants

Ambient air quality standards in California are the responsibility of, and have been established by, both the U.S. EPA and CARB. These standards have been set at concentrations, which provide margins of safety for the protection of public health and welfare. Federal and state air quality standards are presented in Table 3.2-1. The federal, state, and local air quality regulations are identified below in further detail.

3.2.2.1.1 Federal Regulations

The U.S. EPA is responsible for setting and enforcing the National Ambient Air Quality Standards for ozone, CO, NO_2, SO_2, PM_{10}, $PM_{2.5}$, and lead. The U.S. EPA has jurisdiction over emissions sources that are under the authority of the federal government including aircraft, locomotives, and emissions sources outside state waters (Outer Continental Shelf). The U.S. EPA also establishes emission standards for vehicles sold in states other than California. Automobiles sold in California must meet the stricter emission requirements of the CARB.

The Clean Air Act (CAA) Amendments of 1990 give the U.S. EPA additional authority to require states to reduce emissions of ozone precursors and particulate matter in non-attainment areas. The amendments set attainment deadlines based on the severity of problems. At the state level, CARB has traditionally established state ambient air quality standards, maintained oversight authority in air quality planning, developed programs for reducing emissions from motor vehicles, developed air emission inventories, collected air quality and meteorological data, and approved state implementation plans. At a local level, California's air districts, including the Air District, are responsible for overseeing stationary source emissions, approving permits, maintaining emission inventories, maintaining air quality stations, overseeing agricultural burning permits, and reviewing air quality-related sections of environmental documents required by CEQA.

Other federal regulations applicable to the Bay Area include Title III of the Clean Air Act, which regulates toxic air contaminants. Title V of the Act establishes a federal permit program for large stationary emission sources. The U.S. EPA also has authority over the Prevention of Significant Deterioration (PSD) program, as well as the New Source Performance Standards (NSPS), both of which regulate stationary sources under specified conditions.

3.2.2.1.2 California Regulations

CARB, which became part of the California Environmental Protection Agency in 1991, is responsible for ensuring implementation of the California Clean Air Act and federal Clean Air Act, and for regulating emissions from consumer products and motor vehicles. CARB has established California Ambient Air Quality Standards for all pollutants for which the federal government has established National Ambient Air Quality Standards and also has standards for sulfates, visibility, hydrogen sulfide and vinyl chloride. Federal and state air quality standards are presented in Table 3.2-1 under Air Quality Environmental Setting. California standards are generally more stringent than the National Ambient Air Quality Standards. CARB has established emission standards for vehicles sold in California and for various types of combustion equipment. CARB also sets fuel specifications to reduce vehicular emissions.

CARB released the Proposed 2016 State Strategy for the State Implementation Strategy on May 17, 2016. The measures contained in the State SIP Strategy reflect a combination of state actions, petitions for federal action, and actions for deployment of cleaner technologies in all sectors. CARB's proposed state SIP Strategy includes control measures for on-road vehicles, locomotives, ocean going vessels, and off-road equipment that are aimed at helping all districts in California to comply with federal and state ambient air quality standards.

California gasoline specifications are governed by both state and federal agencies. During the past two decades, federal and state agencies have imposed numerous requirements on the production and sale of gasoline in California. CARB adopted the Reformulated Gasoline Phase III regulations in 1999, which required, among other things, that California phase out the use of MTBE in gasoline. The CARB Reformulated Gasoline Phase III regulations have been amended several times (the most recent amendments were adopted in 2013) since the original adoption by CARB.

The California Clean Air Act (AB2595) mandates achievement of the maximum degree of emission reductions possible from vehicular and other mobile sources in order to attain the state ambient air quality standards by the earliest practical date.

3.2.2.1.3 Air District Regulations

The California Legislature created the Air District in 1955. The Air District is responsible for regulating stationary sources of air pollution in the nine counties that surround San Francisco Bay: Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, southwestern Solano, and southern Sonoma counties. The District is governed by a 24-member Board of Directors composed of publicly-elected officials apportioned according to the population of the represented counties. The Board has the authority to develop and enforce regulations for the control of air pollution within its jurisdiction. The District is responsible for implementing emissions standards and other requirements of federal and state laws. Numerous regulations have been developed by the District to control emissions sources within its jurisdiction. It is also responsible for developing air quality planning documents required by both federal and state laws.

Bay Area facilities are subject to various air quality regulations that have been adopted by the Air District, CARB and U.S. EPA. These rules contain standards that are expressed in a variety of forms to ensure that emissions are effectively controlled including:

- Requiring the use of specific emission control strategies or equipment (e.g., the use of floating roof tanks for ROG emissions);
- Requiring that emissions generated by a source be controlled by at least a specified percentage (e.g., 95 percent control of ROG emissions from pressure relief devices);
- Requiring that emissions from a source not exceed specific concentration levels (e.g., 100 parts per million (ppm) by volume of ROG for equipment leaks, unless those leaks are repaired within a specific timeframe; 250 ppm by volume SO_2 in exhaust gases from sulfur recovery units; 1,000 ppm by volume SO_2 in exhaust gases from catalytic cracking units);
- Requiring that emissions not exceed certain quantities for a given amount of material processed or fuel used at a source (e.g., 0.033 pounds NOx per million BTU of heat input, on a refinery-wide basis, for boilers, process heaters, and steam generators);
- Requiring that emissions be controlled sufficient to not result in off property air concentrations above specified levels (e.g., 0.03 ppm by volume of hydrogen sulfide (H_2S) in the ambient air);
- Requiring that emissions from a source not exceed specified opacity levels based on visible emissions observations (e.g., no more than 3 minutes in any hour in which emissions are as dark or darker than No. 1 on the Ringelmann chart); and
- Requiring that emissions be minimized by the use of all feasible prevention measures (e.g., flaring prohibited unless it is in accordance with an approved Flare Minimization Plan).
- Requiring that emissions of non-methane organic compounds and methane from the waste decomposition process at solid waste disposal sites be limited.
- Requiring emission limits on ozone precursor organic compounds from valves and flanges.
- Requiring the limitation of emissions of organic compounds from gasoline dispensing facilities.

3.2.2.2 Toxic Air Contaminants

3.2.2.2.1 Federal and State Regulations

TACs are regulated in the District through federal, state, and local programs. At the federal level, TACS are regulated primarily under the authority of the CAA. Prior to the amendment of the CAA in 1990, source-specific NESHAPs were promulgated under Section 112 of the CAA for certain sources of radionuclides and hazardous air pollutants (HAPs).

Title III of the 1990 CAA amendments required the U.S. EPA to promulgate NESHAPs on a specified schedule for certain categories of sources identified by the U.S. EPA as emitting one or more of the 189 listed HAPs. Emission standards for affected sources must require the maximum achievable control technology (MACT). MACT is defined as the maximum degree of emission reduction achievable considering cost and non-air quality health and environmental impacts and energy requirements. All NESHAPs were promulgated by May 2015.

Many sources of TACs that have been identified under the CAA are also subject to the California TAC regulatory programs. CARB developed four regulatory programs for the control of TACs. Each of the programs is discussed in the following subsections.

Control of TACs Under the TAC Identification and Control Program: California's TAC identification and control program, adopted in 1983 as Assembly Bill 1807 (AB 1807) (California Health and Safety Code §39662), is a two-step program in which substances are identified as TACs, and airborne toxic control measures (ATCMs) are adopted to control emissions from specific sources. Since adoption of the program, CARB has identified 18 TACs, and CARB adopted a regulation designating all 189 federal HAPs as TACs.

Control of TACs Under the Air Toxics "Hot Spots" Act: The Air Toxics Hot Spot Information and Assessment Act of 1987 (AB 2588) (California Health and Safety Code §39656), as amended by Senate Bill (SB) 1731, establishes a state-wide program to inventory and assess the risks from facilities that emit TACs and to notify the public about significant health risks associated with those emissions. AB2588 requires operators of certain stationary sources to inventory air toxic emissions from their operation and, if directed to do so by the local air district, prepare a health risk assessment to determine the potential health impacts of such emissions. If the health impacts are determined to be "significant" (greater than 10 per million exposures or non-cancer chronic or acute hazard index greater than 1.0), each facility must, upon approval of the health risk assessment, provide public notification to affect individuals.

Community Air Protection Program (AB 617): The Community Air Protection Program was established under AB 617 to reduce exposure in communities most impacted by air pollution. The Program includes community air monitoring and community emissions reduction programs, as well as funding to support early actions to address localized air pollution through targeted incentive funding to deploy cleaner technologies in these impacted communities. AB 617 also includes new requirements for accelerated retrofit of pollution controls on industrial sources, increased penalty fees, and greater transparency and availability of air quality and emissions data, which will help advance air pollution control efforts. CARB is required to select the communities for action in the first year of the program and develop the program requirements by October 2018. The 2018 communities in the Bay Area recommended by CARB staff for approval by the CARB Governing Board are Richmond and West Oakland.

3.2.2.2.2 District TAC Rules and Regulations

The Air District uses three approaches to reduce TAC emissions and to reduce the health impacts resulting from TAC emissions: 1) Specific rules and regulations; 2) Pre-construction review; and, 3) the Air Toxics Hot Spots Program. In addition, the Air

District implements U.S. EPA, CARB, and Air District rules that specifically target toxic air contaminant emissions from sources at petroleum refineries.

District Rules and Regulations: The Air District has a number of rules that reduce or control emissions from stationary sources. A number of regulations that control criteria pollutant emissions also control TAC emissions. For example, inspection and maintenance programs for fugitive emission sources (e.g., pumps, valves, and flanges) control ROG emissions, some of which may also be TAC emissions. Also, as discussed above, the District's Rule 11-18: Reduction from Air Toxic Emissions at Existing Facilities requires a review of TAC emissions, health risk assessments for facilities that have priority scores above a certain level, and risk reduction measures or installation of Best Available Retrofit Control Technology for Toxics on all significant sources of toxic emissions, if certain health risks are exceeded.

Preconstruction Review: The Air District's Regulation 2, Rule 5 is a preconstruction review requirement for new and modified sources of TACs implemented through the Air District's permitting process. This rule includes health impact thresholds, which require the use of the best available control technology for TAC emissions (TBACT) for new or modified equipment, and health risk limits cannot be exceeded for any proposed project.

Air Toxics Hot Spots Program: The Air Toxic Hot Spots program, or AB2588 Program, is a statewide program implemented by each individual air district pursuant to the Air Toxic Hot Spots Act of 1987 (Health and Safety Code Section 44300 et. seq.). The Air District uses standardized procedures to identify health impacts resulting from industrial and commercial facilities and encourage risk reductions at these facilities. Health impacts are expressed in terms of cancer risk and non-cancer hazard index. Under this program, the Air District uses a prioritization process to identify facilities that warrant further review. This prioritization process uses toxic emissions data, health effects values for TACs, and Air District approved calculation procedures to determine a cancer risk prioritization score and a non-cancer prioritization score for each site. The District updates the prioritization scores annually based on the most recent toxic emissions inventory data for the facility.

Facilities that have a cancer risk prioritization score greater than 10 or a non-cancer prioritization greater than 1 must undergo further review. If emission inventory refinements and other screening procedures indicate that prioritizations scores remain above the thresholds, the Air District will require that the facility perform a comprehensive site-wide HRA.

In 1990, the Air District Board of Directors adopted the current risk management thresholds pursuant to the Air Toxic "Hot Spots" Act of 1987. These risk management thresholds, which are summarized in Table 3.2-7 below, set health impact levels that require sites to take further action, such as conducting periodic public notifications about the site's health impacts and implementing mandatory risk reduction measures.

TABLE 3.2-7

Summary of Bay Area Air Toxics Hot Spots Program Risk Management Thresholds

Requirement	Site Wide Cancer Risk	Site Wide Non-Cancer Hazard Index
Public Notification	Greater than 10 in one million	Greater than 1
Mandatory Risk Reduction	Greater than 100 in one million	Greater than 10

Targeted Control of TACs Under the Community Air Risk Evaluation Program: In 2004, the Air District established the Community Air Risk Evaluation (CARE) program to identify locations with high emissions of toxic air contaminants (TAC) and high exposures of sensitive populations to TAC and to use this information to help establish policies to guide mitigation strategies that obtain the greatest health benefit from TAC emission reductions. For example, the Air District will use information derived from the CARE program to develop and implement targeted risk reduction programs, including grant and incentive programs, community outreach efforts, collaboration with other governmental agencies, model ordinances, new regulations for stationary sources and indirect sources, and advocacy for additional legislation.

The CARE program was initiated to evaluate and reduce health risks associated with exposures to outdoor TACs and other pollutants in the Bay Area. The program examines emissions from point sources, area sources, and on-road and off-road mobile sources with an emphasis on diesel exhaust, which is a major contributor to airborne health risk in California. The main objectives of the program are to:

- Characterize and evaluate potential cancer and non-cancer health risks associated with exposure to TACs and other pollutants from both stationary and mobile sources throughout the Bay Area.
- Assess potential exposures to sensitive populations including children, senior citizens, and people with respiratory illnesses.
- Identify significant sources of emissions and prioritize use of resources to reduce exposure in the most highly impacts areas (i.e., priority communities).
- Develop and implement mitigation measures such as grants, guidelines or regulations, to achieve cleaner air for the public and the environment, focusing initially on priority communities.

The CARE program is an on-going program that encourages community involvement and input. The technical analysis portion of the CARE program is being implemented in three phases that includes an assessment of the sources of TAC emissions, modeling and measurement programs to estimate concentrations of TAC, and an assessment of exposures and health risks. Throughout the program, information derived from the technical analyses will be used to focus emission reduction measures in areas with high TAC exposures and high density of sensitive populations.

The District's Regulation 11, Rule 18: Reduction from Air Toxic Emissions at Existing Facilities: Rule 11-18, adopted November 15, 2017, requires the District to conduct screening analyses for facilities that report TAC emissions within the District and calculate health prioritization scores based on the amount of TAC emissions, the toxicity of the TAC pollutants, and the proximity of the facilities to local communities. The District will conduct health risk assessments for facilities that have priority scores above a certain level. Based on the health risk assessment, facilities found to have a potential health risk above the risk action level would be required to reduce their risk below the action level, or install Best Available Retrofit Control Technology for Toxics on all significant sources of toxic emissions.

A partial list of the air pollution rules and regulations that the Air District implements and enforces at Bay Area facilities follows:

- Air District Regulation 1: General Provisions and Definitions
- Air District Regulation 2, Rule 1: Permits, General Requirements
- Air District Regulation 2, Rule 2: New Source Review
- Air District Regulation 2, Rule 5: New Source Review of Toxic Air Contaminants
- Air District Regulation 2, Rule 6: Major Facility Review (Title V)
- Air District Regulation 6, Rule 1: Particulate Matter, General Requirements
- Air District Regulation 6, Rule 2: Miscellaneous Operations
- Air District Regulation 8, Rule 5: Storage of Organic Liquids
- Air District Regulation 8, Rule 6: Terminals and Bulk Plants
- Air District Regulation 8, Rule 7: Gasoline Dispensing Facilities
- Air District Regulation 8, Rule 8: Wastewater (Oil-Water) Separators
- Air District Regulation 8, Rule 9: Vacuum Producing Systems
- Air District Regulation 8, Rule 10: Process Vessel Depressurization
- Air District Regulation 8, Rule 18: Equipment Leaks
- Air District Regulation 8, Rule 22: Valves and Flanges at Chemical Plants
- Air District Regulation 8, Rule 28: Episodic Releases from Pressure Relief Devices at Petroleum Refineries and Chemical Plants
- Air District Regulation 8, Rule 33: Gasoline Bulk Terminals and Gasoline Delivery Vehicles
- Air District Regulation 8, Rule 39: Gasoline Bulk Terminals and Gasoline Delivery Vehicles
- Air District Regulation 8, Rule 44: Marine Vessel Loading Terminals
- Air District Regulation 9, Rule 1: Sulfur Dioxide
- Air District Regulation 9, Rule 2: Hydrogen Sulfide
- Air District Regulation 9, Rule 7: Nitrogen Oxides and Carbon Monoxide from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters

- Air District Regulation 9, Rule 8: Nitrogen Oxides and Carbon Monoxide from Stationary Internal Combustion Engines
- Air District Regulation 9, Rule 9: Nitrogen Oxides and Carbon Monoxide from Stationary Gas Turbines
- Air District Regulation 9, Rule 10: Nitrogen Oxides and Carbon Monoxide from Boilers, Steam Generators and Process Heaters in Petroleum Refineries
- Air District Regulation 9, Rule 11: Nitrogen Oxides And Carbon Monoxide from Utility Electric Power Generating Boilers
- Air District Regulation 11, Rule 1: Lead
- Air District Regulation 11, Rule 8: Hexavalent Chromium
- Air District Regulation 11, Rule 18: Risk Reduction from Air Toxic Emissions at Existing Facilities
- Air District Regulation 12, Rule 11: Flare Monitoring at Petroleum Refineries
- Air District Regulation 12, Rule 12: Flares at Petroleum Refineries
- 40 CFR Part 63, Subpart CC: Petroleum Refineries (NESHAP)
- 40 CFR Part 63, Subpart UUU: Petroleum Refineries: Catalytic Cracking, Catalytic Reforming, and Sulfur Plant Units (NESHAP)
- 40 CFR Part 61, Subpart FF: Benzene Waste Operations (NESHAP)
- 40 CFR Part 60, Subpart J: Standards of Performance for Petroleum Refineries (NSPS)
- State Airborne Toxic Control Measure for Stationary Compression Ignition (Diesel) Engines (ATCM)

3.2.3 SIGNIFICANCE CRITERIA

On June 2, 2010, the District's Board of Directors unanimously adopted thresholds of significance to assist in the review of projects under CEQA. These CEQA thresholds were designed to establish the level at which the District believed air pollution emissions would cause significant environmental impacts under CEQA. The CEQA thresholds were challenged in court. Following litigation in the trial court, the court of appeal, and the California Supreme Court, all of the Thresholds were upheld. However, in an opinion issued on December 17, 2015, the California Supreme Court held that CEQA does not generally require an analysis of the impacts of locating development in areas subject to environmental hazards unless the project would exacerbate existing environmental hazards.

In view of the Supreme Court’s opinion, local agencies may rely on the District’s CEQA thresholds designed to reflect the impact of locating development near areas of toxic air contamination where such an analysis is required by CEQA or where the agency has determined that such an analysis would assist in making a decision about the project. However, the CEQA thresholds are not mandatory and agencies should apply them only after determining that they reflect an appropriate measure of a project’s impacts.

The Air District published a new version of the Guidelines dated May 2017, which includes revisions made to address the Supreme Court’s opinion. The CEQA Guidelines for implementation of the Thresholds are for information purposes only to assist local agencies. Recommendations in the Guidelines are advisory and should be followed by local governments at their own discretion. The Air District is currently working to revise any outdated information in the Guidelines as part of its update to the CEQA Guidelines and thresholds of significance. Since these are the most current air quality significance thresholds and address court decisions, they will be used in the CEQA analysis for the current project.

3.2.3.1 Construction Emissions

Regarding construction emissions, the Air District's 2017 Thresholds of Significance will be used in the current air quality analysis for construction emissions (see Table 3.2-8).

TABLE 3.2-8

Thresholds of Significance for Construction-Related Criteria Air Pollutants and Precursors

Pollutant/Precursor	Daily Average Emissions (lbs/day)
ROG	54
NOx	54
PM_{10}	82*
$PM_{2.5}$	54*
PM_{10}/ $PM_{2.5}$ Fugitive Dust	Best Management Practices

*Applies to construction exhaust emissions only.
Source: BAAQMD, 2017a

3.2.3.2 Operational Emissions

The most recently available CEQA Guidelines established emission thresholds for specific projects, general plans, and regional plans. An air quality rule does not fall neatly into any of these categories. Air quality rules are typically regional in nature, as opposed to general plans, community plans and regional plans. In addition, air quality rules are usually specific to particular source types and particular pollutants. The Air Quality Plan threshold of "no net increase in emissions" is appropriate for Air Quality Plans because they include a mix of several control measures with individual trade-offs. For example, one control measure may result in combustion of methane to reduce greenhouse gas emissions, while increasing criteria pollutant emissions by a small amount. Those increases from the methane measure would be offset by decreases from other measures focused on reducing criteria pollutants. In a particular rule development effort, there may not be opportunities to make these trade-offs.

The 2017 project-level stationary source CEQA thresholds are identified in Table 3.2-8. These represent the levels at which a project's individual emissions would result in a cumulatively considerable contribution to the Air District's existing air quality conditions for individual projects. These thresholds are based on the federal offset requirements for ozone precursors for which the Bay Area is designated as a non-attainment area, which is an appropriate approach to prevent further deterioration of ambient air quality and thus has nexus and proportionality to prevent regionally cumulative significant impacts (e.g., worsened status of non-attainment). Despite being a non-attainment area for state PM_{10} and pending nonattainment for federal $PM_{2.5}$, the federal NSR significant emission rate annual limits of 15 and 10 tons per year, respectively, are the thresholds as the District has not established an offset requirement limit for $PM_{2.5}$ and the existing limit of 100 tons per year is much less stringent and would not be appropriate in light of the pending non-attainment designation for the federal 24-hour $PM_{2.5}$ standards. These operational thresholds represent the emission levels above which a project's individual emissions would result in a cumulatively considerable contribution to the Bay Area's existing air quality conditions. The Air District is planning to develop significance thresholds specifically for rules. Until that effort is complete and in order to provide a conservative air quality analysis, the project-specific thresholds recommended in the revised 2017 CEQA Guidelines (BAAQMD, 2017) will be used in the current air quality impacts analysis (see Table 3.2-9).

TABLE 3.2-9

Thresholds of Significance for Operation-Related Criteria Air Pollutants and Precursors

Pollutant/Precursor	Daily Average Emissions (lbs/day)	Maximum Annual Emissions (tons/year)
ROG	54	10
NOx	54	10
PM_{10}	82	15
$PM_{2.5}$	54	10

*Source: BAAQMD, 2017a

3.2.4 ENVIRONMENTAL IMPACTS

As discussed previously, the NOP/IS (see Appendix A) found that the Expedited BARCT Implementation Schedule would require industrial facilities to install new or modify their existing air pollution control equipment. Under the Expedited BARCT Implementation Schedule, facilities that participate in the GHG Cap-and-Trade system in the Bay Area would be required to implement BARCT to reduce their criteria pollutant emissions. In the NOP/IS, air quality impacts were noted to be potentially significant and further analyzed and discussed in this section.

It is expected that the direct effects of the Expedited BARCT Implementation Schedule would be reductions in criteria pollutant and TAC emissions. However, construction equipment and activities to install air pollution control equipment has the potential to generate secondary air quality impacts, primarily from exhaust emissions. Further, air pollution control equipment that reduces one or more regulated pollutants has the potential to generate adverse secondary air quality impacts from other sources such as mobile sources or from the air pollution control equipment. For example, some types of air pollution control equipment that use caustic as part of the control process have the potential to generate emissions of the caustic material that may be considered a TAC.

Potential secondary air quality impacts from construction activities and equipment that may be required under the Expedited BARCT Implementation Schedule are analyzed herein. The analysis identifies construction air quality impacts from air pollution control equipment that could be installed to comply with AB 617 requirements (e.g., SCRs, vapor recovery units, wet gas scrubber, etc.). Construction and operation air quality impacts are identified and provided in the following subsections.

There are a total of six rule development projects that are being evaluated under the Expedited BARCT Implementation Schedule. Of these six projects, only the Refinery Heavy Liquid Leaks project is expected to implement control measures that will have minor or no construction or operational air quality impacts.

The Refinery Heavy Liquid Leaks Project is expected to require increased LDAR in order to achieve BARCT requirements. The amendments for Regulation 8, Rule 18: Equipment Leaks have currently not been fully implemented due to litigation, making expected emissions reductions difficult to estimate. However, increase LDAR is not expected to have any air quality impacts as it would require additional monitoring of fugitive emissions and repair of equipment found to be leaking. No construction is required and LDAR does not use equipment that would contribute to air quality impacts during operation.

The overall emission benefits that are expected from the Expedited BARCT Implementation Schedule are presented in Table 3.2-10. For some of the potential rule development projects, emission reductions may be unknown at this time. For particular sources or pollutants, there may be uncertainties associated with emission estimates or the level of control and emission reductions achievable, and further study and evaluation would be required to develop more detailed estimates. For example, potential emission reductions of condensable PM are often difficult to quantify due to the complex nature of condensable PM formation. This formation can be highly dependent on site-specific source parameters, including flue gas properties and composition. Because control strategies typically involve the reduction of condensable components and precursors (such as ammonia and SO_2) instead of a direct limit on condensable PM, reductions of condensable PM emissions associated with these control measures may be difficult to estimate without specific engineering information.

TABLE 3.2-10

Expedited BARCT Implementation Schedule Emission Reductions Associated with Rule Development Projects

Rule Development Project Title	Estimated Emission Reductions Criteria Air Pollutants (tons/yr)				
	ROG	CO	NOx	SOx	PM
Organic Liquid Storage Tanks[1]	75 - 125	--	--	--	--
Petroleum Wastewater Treating	Unknown[(2)]	--	--	--	--
Portland Cement Manufacturing	--	--	--	698	Unknown
Refinery Fluid Catalytic Crackers and CO Boilers	--	--	--	567	Unknown
Refinery Heavy Liquid Leaks	Unknown	--	--	--	--
Petroleum Coke Calcining	--	--	Unknown	--	--

(1) The Organic Liquid Storage Tanks Project, Petroleum Wastewater Treating and Refinery Heavy Liquid Leak projects will also reduce TAC emissions. TAC emissions are not readily quantifiable and are thus not presented.
(2) For some of the potential rule development projects the estimates of emissions reductions are unknown at this time. This is due to uncertainties associated with emission estimates or the level of control and emission reductions that are achievable.

3.2.4.1 Potential Criteria Pollutant Impacts during Construction

The proposed project aims to reduce a wide variety of criteria pollutants. Different types of control technologies may need to be installed, as necessary, at affected facilities to achieve the goals of the Expedited BARCT Implementation Schedule. The potential secondary adverse air quality construction impacts from control equipment identified in Chapter 2 that may be installed to comply with the Expedited BARCT Implementation Schedule (see Table 2-4) have been analyzed in the following subsections.

The Expedited BARCT Implementation Schedule has the potential to affect industrial facilities in the Bay Area that are subject to Cap-and-Trade requirements, which include cement manufacturing facilities, refineries, and organic liquid storage facilities. Many of these facilities are expected to install various air pollution control equipment or use other means to achieve BARCT requirements.

Construction equipment associated with installing air pollution control technologies would result in ROG, NOx, SOx, CO, PM_{10}, and $PM_{2.5}$ emissions, although the amount generated by specific types of equipment can vary greatly. As shown in Table 3.2-11, different types of equipment can generate construction emissions in much different quantities depending on the type of equipment. For example, the estimated emissions of NOx range from of

0.17 pound per hour (lb/hr) of NOx for a forklift to 1.06 lbs/hr for a large drill rig. To provide a conservative construction air quality analysis and in the absence of information on the specific construction activities necessary to complete a construction project, a typical construction analysis assumes that, in the absence of specific information, all construction activities would occur for eight hours per day. This is considered a conservative assumption because workers may need to be briefed on daily activities, so construction may start later than their arrival times or the actual construction activities may not require eight hours to complete. However, for some construction projects, specific types of construction equipment and hours of operation have been developed using analyses prepared for other similar types of construction projects or using construction estimator guidelines used by construction contractors when bidding on jobs. As a result, under some construction scenarios hours of equipment operation may be more or less than eight hours.

TABLE 3.2-11

Emission Factors Associated with Typical Construction Equipment(1)

Equipment Type	VOC (lb/hr)	CO (lb/hr)	NOx (lb/hr)	SOx (lb/hr)	PM (lb/hr)
Aerial Lift	0.00	0.17	0.10	0.00	0.00
Backhoe	0.02	0.36	0.27	0.00	0.02
Compressor	0.02	0.21	0.13	0.00	0.01
Concrete Saw	0.03	0.25	0.18	0.00	0.02
Crane	0.05	0.40	0.72	0.00	0.03
Drill Rig Large	0.08	0.50	1.06	0.00	0.04
Excavator	0.02	0.51	0.31	0.00	0.01
Forklift	0.02	0.22	0.17	0.00	0.01
Front End Loader	0.05	0.44	0.60	0.00	0.03
Generator	0.02	0.22	0.13	0.00	0.01
Light Plants	0.02	0.29	0.13	0.00	0.01
Welding Machine	0.03	0.23	0.18	0.00	0.02

(1) Emission Factors from Off-Road 2011, Model Year 2019. CO emissions from SCAQMD, 2006: http://www.aqmd.gov/ceqa/handbook/offroad/offroadEF07_25.xls.

A range of construction scenarios for installing various types of control equipment was identified to determine whether or not construction air quality impacts would exceed any applicable air quality significance thresholds. To provide a conservative analysis of potential construction air quality impacts, it is assumed that construction of one or more of the control technologies evaluated in the following subsections could overlap. The following subsections identify construction scenarios that may occur for control technologies and are considered to be a representative range of construction activities and equipment used to install air pollution control equipment. Construction activities range from installing or retrofitting small-scale air pollution control equipment, which would require few pieces of construction equipment or hours of operation, to installing large-scale air pollution control technologies, which require larger construction crews, more construction equipment, and longer hours of operation. As shown in the following subsections, construction activities could result in substantial construction air quality impacts.

3.2.4.1.1 Air Pollution Control Equipment with Minor Construction Activities

Both the Organic Liquid Storage Tanks Rule Development Project and Petroleum Wastewater Treating Rule Development Project aim to reduce ROG emissions at refineries. These emission reductions are expected to be met through the installation of domes for external floating roof tanks, vapor recovery units and/or thermal incinerators for the Organic Liquid Storage Tanks Rule and through the installation of vapor combustors for the Petroleum Wastewater Treating Rule. While some vapor recovery units require less combustion than thermal incinerators or vapor combustors, any control devices with vapor combustion are evaluated together as oxidizers. All vapor recovery devices are all expected to require minor construction activities in order to install the requisite equipment.

<u>Oxidizers</u>

A Negative Declaration was prepared for Rule 2-5 New Source Review for Toxic Air Contaminants (SS21) which estimated the construction emissions associated with installation of oxidizers. The construction equipment that would most likely be required for the installation of a refinery oxidizer, during a peak month is provided in Table 3.2-12. This EIR assumes that each refinery would implement one vapor combustor for their respective petroleum wastewater treatment plant, resulting in a total of 5 vapor combustors for the Petroleum Wastewater Treating Rule Development Project. For the Organic Liquid Storage Tank Rule Development Project, this EIR assumes that up to 10 oxidizers may be installed. This estimate is based on the number of external floating roof tanks identified that may be subject to these BARCT requirements, and assumes that each oxidizer may be applied to multiple tanks (up to 2 tanks per oxidizer). Therefore, it is conservatively estimated that up to 15 total oxidizers could be installed in order to meet BARCT requirements; however, it is unlikely that all 15 units would be installed concurrently. This EIR assumes that a maximum of five units would share overlapping construction emissions, as shown in Table 3.2-13.

TABLE 3.2-12

Estimated Construction Equipment for Installing One Oxidizer

Off- Road Equipment Type	Number	Daily Hours of Use
Backhoes	2	8
Cement and Mortar Mixers	1	8
Cranes	1	8
Dozers	1	8
Forklifts	1	8
Generator	1	8

Pavers	1	8
Rollers	1	8

(1) Reference: SCAQMD, 2016a

Table 3.2-13

Estimated Construction Emissions for Oxidizers

ACTIVITY	ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$
Construction Emissions from Oxidizers on Refinery Units(1) (lbs/day)						
Construction Activities for 1 Oxidizer	0.03	0.35	0.45	0.00	0.15	0.07
Overlapping Construction Emissions for 5 Oxidizers	0.15	1.74	2.25	0.01	0.76	0.33
Total Construction Estimates for Oxidizers on Refinery Units (tons emitted during construction period – tons/yr)						
Construction Activities for 1 Oxidizer(2)	0.000	0.004	0.005	0.000	0.002	0.001
Overlapping Construction Emissions for 5 Oxidizers	0.002	0.018	0.024	0.000	0.008	0.003

(1) Reference: SCAQMD, 2016a
(2) Construction of oxidizers is expected to take 21 working days

Domes

The Organic Liquid Storage Tanks Rule Development Project is expected to require the addition of domes to existing external floating roof tanks. A typical external floating roof tank consists of an open- topped cylindrical steel shell equipped with a roof that floats on the surface of the stored liquid. The floating roof consists of a deck, fittings, and rim seal system. External floating decks are equipped with a rim seal system, which is attached to the deck perimeter and contacts the tank wall. The purpose of the floating roof and rim seal system is to reduce evaporative loss of the stored liquid. Some annular space remains between the seal system and the tank wall. The seal system slides against the tank wall as the roof is raised and lowered. The floating deck is also equipped with fittings that penetrate the deck and serve operational functions. The external floating roof design is such that evaporative losses from the stored liquid are limited to losses from the rim seal system and deck fittings (standing storage loss) and any exposed liquid on the tank walls (withdrawal loss).

Domed floating roof tanks have the heavier type of deck used in external floating roof tanks as well as a fixed roof at the top of the shell like internal floating roof tanks. Domed external floating roof tanks usually result from retrofitting an external floating roof tank with a fixed roof. As with the internal floating roof tanks, the function of the fixed roof is not to act as a vapor barrier, but to block the wind (thus, minimizing evaporative losses). The type of fixed roof most commonly used is a self-supporting aluminum dome roof, which is of bolted construction. The estimated construction equipment needed to install one dome on an existing refinery floating roof tank is presented in Table 3.2-14 and detailed emission calculations are provided in Appendix B. The overall estimated emissions from installing floating roof tank domes are presented in Table 3.2-15. Based on the number of external floating roof tanks identified that may be subject to these BARCT requirements, it is estimated that up to 20 dome retrofits could be installed; however, it is unlikely that all 20 units would be installed concurrently. This EIR assumes that a maximum of five units would share overlapping construction emissions.

TABLE 3.2-14

Estimated Construction Equipment for Installing One Dome

Off- Road Equipment Type	Number	Daily Hours of Use
Aerial Lift	1	8
Air Compressor	1	8
Crane	1	8
Forklift	2	8
Generator Sets	4	8
Welder	4	8

Table 3-2-15

Estimated Construction Emissions for Domes

ACTIVITY	ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$
Peak Daily Emissions (lb/day)						
Construction of One Dome	2.43	24.78	23.37	0.07	2.59	1.57
Construction of Five Concurrent Domes	12.17	123.89	116.87	0.35	12.97	7.85
Peak Emissions (tons)						
Construction of One Dome	0.02	0.23	0.17	0.00	0.01	0.01
Construction of Five Dome	0.11	1.16	0.84	0.00	0.06	0.06
Construction of 20 Domes	0.43	4.64	3.35	0.01	0.25	0.22

See Appendix B for detailed emission calculations.

The Portland Cement Manufacturing Rule is expected to require additional lime injection in order to reduce PM emissions and SO_2 emissions to BARCT levels. Lime injection already occurs at the cement plant in the Bay Area that would be subject to the BARCT requirements; however, modifications to the system or additional equipment to improve, upgrade, or increase capacity of the system may be required. These may include modifications to or additional installation of storage bins, mixing tanks, and injection equipment. Construction activities would be limited and are assumed to be similar in scope to that of an oxidizer due to the limited size and nature of the additional equipment. The construction equipment that would most likely be required for this activity is provided in Table 3.2-16. Construction emissions are shown in Table 3.2-17.

TABLE 3.2-16

Estimated Construction Equipment for Modifying One Lime Injection System

Off- Road Equipment Type	Number	Daily Hours of Use
Backhoes	2	8
Cement and Mortar Mixers	1	8
Cranes	1	8
Dozers	1	8
Forklifts	1	8
Generator	1	8
Pavers	1	8
Rollers	1	8

(1) Construction activity assumed to be similar to that of 1 oxidizer

Table 3.2-17

Estimated Construction Emissions for Lime Injection System Modifications

ACTIVITY	ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$
Construction Emissions from Lime Injection System Modifications (1) (lbs/day)						
Construction Activities for Modifications to 1 Lime Injection System	0.03	0.35	0.45	0.00	0.15	0.07
Total Construction Estimates for Lime Injection System Modifications (tons emitted during construction period – tons/yr)						
Construction Activities for Modifications to 1 Lime Injection System(2)	0.000	0.004	0.005	0.000	0.002	0.001

(1) Construction activity assumed to be similar to that of 1 oxidizer
(2) Construction expected to take 21 working days

3.2.4.1.2 Air Pollution Control Equipment for Large Construction Activities

One of the projects under the Expedited BARCT Implementation Schedule aims to reduce PM and SO_2 emissions from refinery fluid catalytic crackers and CO boilers. These emissions reductions may be met at three different facilities using WGS and/or ESPs. Two facilities are anticipated to require controls to reduce condensable particulate matter emissions, which may require installation of either one additional ESP system or a WGS system in each facility. Another facility is anticipated to require controls to reduce both condensable particulate matter and SO_2 emissions. For this EIR, all three facilities are conservatively expected to require installation of WGS. Due to the size of a refinery FCCU, these control devices are expected to require substantial construction.

SCR is typically considered to be BACT or BARCT to reduce NOx emissions from large industrial combustion sources; however, the affected facility may install a LoTOx™

system to further control NOx emissions. It is expected that the Petroleum Coke Calcining Rule Development Project may require the coke calciner to install one SCR or one LoTOx™ system in order to meet BARCT for NOx emissions from Bay Area coke calciners.

Wet Gas Scrubbers

WGSs have been used on large scale refinery equipment for the control of particulate matter and SO_2.

The following analysis of the construction impacts associated with installing a WGS is based on an EIR prepared for the installation of a WGS on an FCCU in southern California (SCAQMD, 2007). Because of its large size, it is expected that installing a WGS would occur over a 17-month period; one month to demolish any nearby existing equipment or structures and 16 months to construct the WGS, which would include: site preparation, assembly and installation of the unit and ancillary support equipment, and tying-in the new WGS to the affected equipment. As noted above, this EIR assumes that FCCUs at three facilities might be retrofitted with a WGS under the Schedule. These construction emission estimates from the SCAQMD EIR are appropriate for the construction air quality analysis for the proposed Schedule because they likewise are based on the construction of a WGS on one refinery FCCU. Regardless of the location of the construction activities, the amount or types of construction equipment and hours of operation would not be expected to differ substantially compared to the 2007 analysis. The analysis uses a conservative assumption that equipment would operate for 10 hours per day; this is consistent with the 2007 project which was on an aggressive installation schedule. The construction equipment that would most likely be required for the installation of a refinery WGS, for example, during a peak month is provided in Table 3.2-18.

TABLE 3.2-18

Estimated Peak Day Off-Road Construction Equipment for Installing One Refinery Wet Gas Scrubber

Off- Road Equipment Type	Number	Daily Hours of Use
Backhoe	1	10
Crane	3	10
Front End Loader	1	10
Man Lift	3	10
Forklift	2	10
Generator	1	10
Demolition Hammer	1	10
Welder	3	10

Reference: SCAQMD, 2007

Using worst-case assumptions derived for a WGS constructed at another refinery in California, it is assumed that constructing a WGS would require the use of one or more of the following types of construction equipment: backhoes, cranes, man lifts, forklifts, front end loaders, generators, diesel welding machines, jack hammers, a medium-duty flatbed truck, a medium-duty dump truck, and a cement mixer. Other sources of construction emissions could include: equipment delivery, on-site travel (would include fugitive dust associated with travel on paved roads, and fugitive dust associated with construction activities), and construction worker commute trips (SCAQMD, 2007).

Based on the assumptions used for the construction of a WGS at another refinery in California, it is assumed that up to 50 construction workers would be required for demolition activities. Demolition activities are assumed to require the use of one or more of the following types of equipment: crane, front-end loader, forklift, demolition hammer, water truck, and medium-duty flatbed truck (SCAQMD, 2007). Other sources of demolition emissions could include haul truck trips to dispose of demolition debris, on-site travel (would include fugitive dust associated with travel on paved roads, fugitive dust associated with demolition activities), and construction worker commute trips.

Construction and demolition emission estimates for activities associated with installing one WGS are provided in Table 3.2-19. Typically, construction activities occur sequentially, that is, demolition must be completed before construction activities begin.

TABLE 3.2-19

Estimated Construction Emissions for a Refinery Wet Gas Scrubber

ACTIVITY	ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$
Construction Emissions from one WGS on a Large Refinery Unit(1) (lbs/day)						
Demolition for 1 WGS at Refinery(1)	6	36	28	<1	3	2
Construction Activities for 1 Refinery WGS(1)	17	67	84	<1	39	23
Total Construction Estimates for one WGS on a Large Refinery Unit (tons emitted during construction period)						
Demolition for 1 WGS at Refinery(2)	0.06	0.36	0.28	<0.1	0.03	0.02
Construction Activities for 1 WGS at Refinery(3)	2.04	8.04	10.08	<0.1	4.68	2.76
Total Construction Emissions for 1 WGS(3)	2.10	8.40	10.36	<0.1	4.71	2.78

(1) Reference: SCAQMD 2007
(2) Demolition activities include off-road construction equipment and on-road mobile source emissions and are estimated to occur for one month (20 working days)
(3) Construction activities include off-road construction equipment and on-road mobile source emissions and are estimated to occur for a total of 16 months (20 working days per month), with 8 months at peak construction activities and 8 months at 50 percent of peak construction activities.

Electrostatic Precipitators

ESPs may be installed in order to comply with the Refinery FCCU and CO Boilers Rule Development Project. ESPs used for a refinery FCCU has been previously evaluated in the ExxonMobil SCAQMD Rule 1105.1 Compliance Project (SCAQMD, 2007a). Based on the construction information used from that project, the construction equipment that would most likely be required for the installation of a refinery ESP during a peak month is provided in Table 3.2-20 (SCAQMD, 2007a). Table 3.2-21 summarizes the peak daily construction emissions associated with the installation of a Refinery FCCU ESP. Based on the construction information used for the ESP at the ExxonMobil refinery, construction of an ESP for a refinery FCCU is expected to take approximately 14 months and would occur over four phases: site preparation and foundation laying, equipment installation, QA/QC and equipment tie-in. Peak day emission calculations assume 20 workers per day and that all deliveries would occur in one day (SCAQMD 2007a).

The construction emissions in the ExxonMobil Rule 1105.1 EIR were based on two concurrent ESPs being installed at the same facility. In order to estimate the emissions associated with the construction of one ESP, the duration of the equipment installation phase was reduced by half and recalculated with updated emission factors (see Appendix B for detailed emission calculations).

TABLE 3.2-20

Estimated Peak Day Off-Road Construction Emissions from Installing Two Refinery ESPs

Off- Road Equipment Type	Number	Daily Hours of Use
Backhoe	1	20
Compressor	1	20
Concrete Pump Truck	1	10
Concrete Saw	1	10
Crane	1	20
Drill Rig Large	1	10
Cement Truck	10	1
Excavator	1	20
Forklift	1	20
Front End Loader	1	20
Generator	2	20
Light Plants	2	10

(1) Reference: SCAQMD 2007a

Table 3.2-21

Estimated Peak Daily Emissions from Installing ESP on a Refinery FCCU[1]

ACTIVITY	ROG	CO	NOx	SOx	PM_{10}
Construction Emissions from One ESP on a Refinery FCCU (lbs/day)					
Site Prep and Foundation	5.64	63.56	57.66	0.17	4.67
Equipment Installation	8.09	83.60	65.17	0.20	4.85
QA/QC	2.02	24.43	14.75	0.05	1.20
Tie-in	4.90	60.48	39.20	0.13	2.96
Peak Day Emissions	**8.09[2]**	**83.60**	**65.17**	**0.20**	**4.85**
Total Construction Estimates for ESP on a Refinery FCCU[3] (tons emitted during construction period)					
Construction Activities for One ESP	0.96	10.56	8.42	0.03	0.71

(1) See Appendix B for detailed emission calculations.
(2) Highest daily emissions from the above construction phases.
(3) Assumes 14 months of construction.

<u>Selective Catalytic Reduction</u>

The coke calcining facility subject to the BARCT requirements may install an SCR system to reduce NOx emissions under the proposed project. The following analysis of the construction air quality impacts associated with installing an SCR on a coke calciner is based on an environmental analysis of the effects of further limiting NOx emissions at southern California refineries (SCAQMD, 2015a). These construction emission estimates are appropriate for the construction air quality analysis for the Expedited BARCT Implementation Schedule because they are expected to be similar to emissions produced by the installation of an SCR used for a refinery coke calciner. Regardless of the location of the construction activities, the amount or types of construction equipment and hours of operation, these parameters would not be expected to change. Retrofitting a coke calciner with SCR is estimated to require a total of 260 days of construction, and use a crew of 140 construction workers during peak construction periods (SCAQMD, 2015a). The construction equipment that would most likely be required for installing an SCR on one coke calciner during a peak month is provided in Table 3.2-22.

The construction emission estimates for activities associated with installing one SCR on a coke calciner are provided in Table 3.2-23. Major demolition activities are not expected to be necessary to install an SCR because these units are constructed directly next to or on to the emissions sources' exhaust stacks. A maximum of one SCR is expected to be constructed as a result of the Petroleum Coke Calcining rule development project under the Expedited BARCT Schedule.

TABLE 3.2-22

Estimated Peak Day Off-Road Construction Emissions from Installing One SCR on One Coke Calciner

	Coke Calciner SCR Unit	
Off- Road Equipment Type	**Number**	**Daily Hours of Use**
Air Compressor	1	8
Backhoe	1	8
Concrete Pump	1	2
Concrete Saw	1	2
Crane	2	10
Forklift	1	6
Generator	2	8
Man Lift	2	2
Plate Compactor	1	2
Welder	2	8

Reference: SCAQMD, 2015

TABLE 3.2-23

Estimated Construction Emissions for an SCR Unit on a Coke Calciner

ACTIVITY	ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$
Peak Construction Emissions for One SCR Unit (lbs/day)						
Construction Activities for 1 SCR (1)	1.86	12.02	14.94	0	4.12	3.79
Total Construction On-road Vehicle Trips (2)	5.22	8.58	8.60	0.71	0.47	0.22
Total Construction Emissions	7.08	20.60	23.54	0.71	4.59	4.01
Total Construction Emissions for One SCR Unit (tons emitted during construction period)						
Construction Activities for 1 SCR	0.69	3.18	3.75	0.07	0.85	0.76

Reference: SCAQMD 2015

(1) Construction activities are estimated to occur for a total of 12 months (20 working days per month), with 6 months at peak construction activities and 6 months at 50 percent of peak construction activities.

(2) Vehicle trip assumptions include average vehicle ridership of 1.0 and a trip length of 11 miles one way (CAPCOA, 2016).

LoTOX™ Systems

The coke calcining facility subject to the BARCT requirements may install a LoTOx™ system instead of an SCR to reduce NOx emissions under the proposed project. LoTOx™ stands for "Low Temperature Oxidation" process in which ozone (O_3) is used to oxidize insoluble NOx compounds into soluble NOx compounds which can then be removed by absorption in a caustic, lime, or limestone solution. The LoTOx™ process is a low temperature application, optimally operating at about 325 °F. The LoTOx™ process requires equipment that is similar to a wet gas scrubber, therefore it is assumed that construction activity associated with a LoTOx™ system would be similar to construction activity associated with a refinery WGS. The expected construction equipment needed to construct a refinery LoTOX™ system is presented in Table 3.2-24; estimated construction emissions are presented in Table 3.2-25.

TABLE 3.2-24

Estimated Peak Day Off-Road Construction Equipment for Installing One LoTOX™ System

Off- Road Equipment Type	Number	Daily Hours of Use
Backhoe	1	10
Crane	3	10
Front End Loader	1	10
Man Lift	3	10
Forklift	2	10
Generator	1	10
Demolition Hammer	1	10
Welder	3	10

Reference: SCAQMD, 2007

TABLE 3.2-25

Estimated Construction Emissions for a LoTOX™ Unit on a Refinery Coke Calciner

ACTIVITY(1)	ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$
Peak Daily Emissions (lb/day)						
Demolition	6.00	36.00	28.00	<1	3.00	2.00
Construction	17.00	67.00	84.00	<1	39.00	23.00
Total Emissions (tons)						
Demolition(2)	0.06	0.36	0.28	<0.1	0.03	0.02
Construction(3)	2.04	8.04	10.08	<0.1	4.68	2.76
Total Construction Emissions	2.10	8.40	10.36	<0.1	4.71	2.78

(1) Construction activities are estimated to occur for a total of 12 months (20 working days per month), with 6 months at peak construction activities and 6 months at 50 percent of peak construction activities.

(2) Vehicle trip assumptions include average vehicle ridership of 1.0 and a trip length of 11 miles one way (CAPCOA, 2016).

3.2.4.1.3 Summary of Construction Emission Impacts

As discussed above, construction and installation of some types of air pollution control technologies would not be expected to result in significant adverse construction air quality impacts. For example, the installation of oxidizers under the Organic Liquid Storage Tanks and Refinery Wastewater Treatment Plants Rule Development Projects would result in few construction activities or related emissions. However, the construction of other equipment would require a more substantial amount of construction equipment and generate more construction emissions. Table 3.2-26 summarizes the potential construction emissions and the potential overlap of construction activities. While the actual construction activities that may occur under the Expedited BARCT Implementation Schedule may not overlap, it is reasonable to assume that there is a potential for overlap due to the process and time restraints placed by the individual rule development projects.

Based on the construction emissions in Tables 3.2-26, it is concluded that construction air quality impacts associated with ROG, NOx, PM_{10}, and $PM_{2.5}$ would be significant. Construction emissions, however, are temporary as construction emissions would cease following completion of construction activities. It is also worth noting that construction emissions may be less than the values shown in Table 3.2-26 depending on the equipment ultimately required to comply with BARCT. Mitigation measures for construction impacts are addressed in Section 3.2.5

TABLE 3.2-26

Worst-Case Construction Emissions Under the AB 617 BARCT Implementation Schedule

ACTIVITY	ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$
Peak Daily Concurrent Construction Emissions (lbs/day)						
5 VRU, Incinerators, or Vapor Combustors	0.2	1.8	2.3	0.1	0.8	0.4
5 Domes	12.2	123.9	116.9	0.4	13.0	7.8
1 Lime Injection System	0.0	0.4	0.5	0.0	0.2	0.1
1 Large SCR	7.1	20.6	23.5	0.7	4.6	4.0
3 Refinery WGS	51	201	252	0.3	117	69
Total Concurrent Emissions (lbs/day)	**70.5**	**347.7**	**395.2**	**1.5**	**135.6**	**81.3**
Significance Thresholds	**54**	**None**	**54**	**None**	**82**	**54**
Significant?	**Yes**	**--**	**Yes**	**--**	**Yes**	**Yes**

3.2.4.2 Potential Criteria Pollutant Impacts During Operation

The net effect of implementing the Expedited BARCT Implementation Schedule is to reduce TAC and criteria pollutant emissions from industrial facilities that participate in the Cap-and-Trade Program. However, some control technologies have the potential to generate secondary or indirect air quality impacts as part of the control process. Table 3.2-

27 lists all the identified air pollution control technologies that may be used to comply with future regulatory requirements under the proposed project, as well as potential secondary or indirect operational air quality impacts associated with some types of air pollution control technologies. Those air pollution control technologies in Table 3.2-27 where no direct or indirect operational air quality impacts were identified are not discussed further. The remaining air pollution control technologies that have the potential to generate secondary or indirect operational air quality impacts will be evaluated further in the following subsections.

The following analyses of potential operational secondary air quality impacts from the proposed project include the following assumption; it is assumed that no additional employees would be needed to operate any new or modified air pollution control equipment, so the existing work force at each affected facility is expected to be sufficient. As such, no workers' commute trip emissions are anticipated for the operation of the new or modified air pollution control equipment.

TABLE 3.2-27

Potential Operational Air Quality Impacts from Installing Air Pollution Control Equipment

Potential Control Technology	Potential Air Quality Impacts	Analyzed Further?
Domes on Storage Tanks	None Identified	**No**
Thermal Incinerator	Minor increase in combustion emissions	**Yes**
Vapor Combustor	Minor increase in combustion emissions	**Yes**
Vapor Recovery Unit	Minor increase in combustion emissions	**Yes**
Additional Lime Injection at Cement Plants	Minor indirect mobile source emission increases	**Yes**
Wet Gas Scrubbers	Minor indirect mobile source emission increases	**Yes**
Electrostatic Precipitator (Wet and Dry)	None identified (STAPPA /ALAPCO, 2000)	**No**
Increased LDAR in Heavy Liquid Service at Refineries	None Identified	**No**
SO_2 Reducing Catalyst	None Identified	**No**
LoTOX™ at Petroleum Coke Calciners	Some ozone "slip", but reaction is rapid, impact is minor (CARB, 2005)	**No**
Selective Catalytic Reduction at Petroleum Coke Calciners	Ammonia slip emissions, minor indirect mobile source emission increases	**Yes**

3.2.4.2.1 Direct Emissions Sources

<u>Oxidizers</u>

Two of the rule development projects that fall under the Expedited BARCT Implementation Schedule are aimed at controlling ROG emissions from organic liquid storage tanks and petroleum wastewater treating, respectively. ROG emission reductions are expected to be met using various oxidizers, including vapor recovery units, vapor combustors, and thermal incinerators. The operation of these oxidizers will create secondary criteria pollutant emissions from combustion.

The potential air quality impacts included the emissions associated with the installation of oxidizers were previously calculated in the 2017 Clean Air Plan EIR (BAAQMD, 2017). The various control technologies aimed at controlling emissions via incineration are expected to have similar emissions. The operational emissions associated with the installation of 3.0 mm Btu/hr oxidizers are summarized in Table 3.2-28. While oxidizers may cause a small increase in criteria pollutant emissions, the Expedited BARCT Implementation Schedule will achieve an overall reduction in ROG and NOx. The emission control devices require air permits to operate. Emissions from vapor recovery devices are generally controlled by using efficient combustion practices and enforced with permit conditions.

TABLE 3.2-28

Potential Operational Air Quality Impacts from Oxidizers

Parameter	ROG	$CO^{(1)}$	$NOx^{(2)}$	SOx	PM_{10}	$PM_{2.5}$
Emission Factor(3)	7.00	0.30	0.04	0.60	7.50	7.50
Emission Factor Units	lb/mmscf	lb/mmbtu	lb/mmbtu	lb/mmscf	lb/mmscf	lb/mmscf
Heater Duty (mmbtu/hr)	3.00	3.00	3.00	3.00	3.00	3.00
Heating Value (btu/scf)	1,050	1,050	1,050	1,050	1,050	1,050
Operational time (hr/day)	8.0	8.0	8.0	8.0	8.0	8.0
Daily Emissions for 1 Oxidizer (lb/day)	**0.16**	**7.10**	**0.88**	**0.01**	**0.17**	**0.17**
Daily Emissions for 15 Oxidizers lbs/day	**2.40**	**106.56**	**13.13**	**0.21**	**2.57**	**2.57**
Annual Emissions for 1 Oxidizer (tons/yr)	**0.03**	**1.30**	**0.16**	**0.00**	**0.03**	**0.03**
Annual Emissions for 15 Oxidizers (tons/yr)	**0.44**	**19.45**	**2.40**	**0.04**	**0.47**	**0.47**

Source: Detailed calculations can be found in BAAQMD, 2017, Appendix A.
(1) Based on 400 ppm
(2) Based on 30 ppm
(3) Default emission factors for natural gas combustion for external combustion sources. SCAQMD Annual Emissions Reporting.

3.2.4.2.2 Delivery Truck Emissions

Truck trips transporting the catalyst, caustic, lime, or ammonia solutions would occur relatively infrequently. Further, a single truck's emissions while delivering caustic solutions from San Jose to Benicia[2], for example, would be minimal, a few pounds per day at most. As shown in Table 3.2-29, indirect mobile source emissions from transporting delivery trucks would be low. Peak day transportation emissions assume four caustic/catalyst trucks and one lime truck (see Appendix B for detailed emission calculations). Note that the delivery truck emissions may be less than the values shown in

[2] Review of caustic suppliers located a chemical supplier in San Jose. The haul truck trip from San Jose to the Valero Refining Company in Benicia would likely represent a conservative trip length assumption because trip lengths to all other affected facilities would be shorter.

Table 3.2-29, depending on the equipment ultimately required to comply with BARCT and the associated delivery of materials required. Truck trip emissions from transporting to and from industrial facilities under the Expedited BARCT Implementation Schedule would not generate significant adverse operational air quality impacts or contribute to significant adverse operational air quality impacts that may be caused by other control technologies.

TABLE 3.2-29

Delivery Truck Emissions

Material	Truck Trips	Estimated Trip Length (mi)	Criteria Pollutant					
			CO	ROG	NOx	SOx	PM_{10}	$PM_{2.5}$
Operational Emissions Per Facility (lbs/day)								
Caustic/Catalyst for 3 WGS Units	6	120	0.24	1.65	7.77	0.03	0.18	0.06
Caustic/Catalyst for LoTox Scrubber	2	120	0.08	0.55	2.59	0.01	0.06	0.02
Lime for Cement Kiln	2	100	0.07	0.46	2.16	0.01	0.05	0.01
Total Peak Daily Emissions			**0.39**	**2.66**	**12.52**	**0.05**	**0.29**	**0.09**
Operational Emissions Per Facility (Tons/year)								
Caustic/Catalyst for 3 WGS	312	120	0.03	0.03	0.21	0.03	0.06	0.03
Caustic/Catalyst for LoTox Scrubber	104	120	<0.01	0.01	0.07	<0.01	0.02	<0.01
Lime for Cement Kiln	365	100	0.01	0.04	0.20	<0.01	0.05	0.01
Total Annual Transport Emissions			**0.05**	**0.08**	**0.48**	**0.05**	**0.13**	**0.05**

Wet Gas Scrubbers

Although the main effect of installing air pollution control equipment is reducing emissions, some types of control equipment require delivery of materials that are a necessary part of the pollution control process. For example, WGS operations require a delivery of fresh catalyst and caustic solution on a daily basis. Therefore, indirect emissions occur from trucks delivering supplies (i.e., fresh catalyst and caustic solution to refill the storage tanks) on a regular basis is expected.

Depending on the size and configuration of the WGS, the sodium hydroxide (NaOH) caustic solution used in the WGS would likely need to be delivered one time per week or a little over 50 additional delivery truck trips per year per unit. For example, catalyst and caustic solutions are typically used in relatively small amounts per day. The use of NaOH (50 percent solution, by weight) caustic in a WGS unit could occur at facilities that already use and store NAOH caustic for other purposes, typically in one 10,000-gallon storage tank. Otherwise, the refinery operator would need to construct a new NaOH caustic storage tank and ancillary piping and other associated equipment.

Truck trips transporting the catalyst/caustic or ammonia solutions would occur relatively infrequently. Further, a single truck's emissions while delivering caustic solutions from San Jose to Benicia[3], for example, would be very low, a few pounds per day at most. As shown in Table 3.2-29, indirect mobile source emissions from transporting the catalyst/caustic would be low. Truck trip emissions from transporting caustic to affected refineries that install a WGS would not generate significant adverse operational air quality impacts or contribute to significant adverse operational air quality impacts that may be caused by other control technologies.

<u>NOx Emission Reductions</u>

The Petroleum Coke Calcining Rule Development Project is expected to include the installation of an SCR or a LoTOx™ system in order to best limit NOx emissions. SCRs have been used to control NOx emissions from stationary sources for many years by promoting chemical reactions in the presence of a catalyst. Installation of new SCR equipment or increasing the control efficiency of existing equipment would be expected to increase the amount of ammonia used for NOx control. SCRs would require the additional delivery of ammonia or urea to the facilities where they are installed. It is estimated that about 40 truck trips per year would be required for the delivery of ammonia/urea. This amount could vary depending on the size of the SCR and size of the ammonia or urea storage systems. However, the 40 trucks per year is expected to provide a conservative estimate of transportation requirements. The emissions associated with these truck deliveries are included in Table 3.2-29 and are expected to be minor. Delivery truck emissions associated with the installation of a LoTOx™ system are expected to be similar to those needed for a WGS as discussed above. The emissions associated with these deliveries are also presented in Table 3.2-29.

The Petroleum Coke Calcining Project could reduce NOx by using SCR, which may potentially result in increased ammonia emissions due to "ammonia slip" (release). As a result, ammonia slip emissions could increase, thus, contributing to $PM_{2.5}$ concentrations. Ammonia can be released in liquid form, thus, directly generating $PM_{2.5}$ emissions. Ammonia can also be released in gaseous form where it is a precursor to $PM_{2.5}$ emissions. Ammonia slip can increase as the catalyst ages and becomes less effective. Ammonia slip from SCR equipment is continuously monitored and controlled. The SCR technology has progressed such that ammonia slip can be limited to five parts per million (ppm) or less. SCR vendors have developed better injection systems that result in a more even distribution of NOx ahead of the catalyst so that the potential for ammonia slip has been reduced. Similarly, ammonia injection rates are more precisely controlled by model control logic units that are a combination of feed-back control and feed forward control using a proportional/integral controller that sets flow rates by predicting SCR outlet ammonia concentrations and calibrating them to a set reference value. Installation of an SCR would require an Authority to Construct from the Air District. A limit on ammonia slip is

[3] Review of caustic suppliers located a chemical supplier in San Jose. The haul truck trip from San Jose to the Valero Refining Company in Benicia would likely represent a conservative trip length assumption because trip lengths to all other affected facilities would be shorter.

normally included in air permits for stationary sources. Operators would be required to monitor ammonia slip by conducting an annual source test and maintain a continuous monitoring system to accurately indicate the ammonia-to-emitted-NOx mole ratio at the inlet of the SCR. These measures are expected to minimize potential air quality impacts associated with ammonia slip.

Additional Lime Injection at Cement Plants

The formation of SO_2 in cement kilns is a product of the chemical make-up of the raw materials and fuel, as well as the high operating temperatures and oxygen concentration in the kiln. The one cement kiln in the District currently operates a lime injection system for the control of SO_2 emissions. A hydrated lime powder is injected into the flue gas. SO_2 reacts with lime (calcium carbonate) and is captured in the baghouse as calcium sulfate. The hydrated lime usually absorbs up to 60% of the SO_2 in the gases if injected at the correct temperature.

The Portland Cement Manufacturing Rule Development Project is expected to require additional lime injection in order to meet BARCT requirements for PM and SO_2. The one facility that would require additional lime injection already has systems in place to administer lime and is not expected to require new equipment to administer additional lime that would generate substantial operational emissions. Additional lime injection will however require additional truck trips in order to deliver the lime to the facility. It is estimated that no more than one truck per day would be needed to meet the new lime demands on the facility. Thus, it is conservatively estimated that 365 truck trips per year would be required for the delivery of additional lime. The annual emissions associated with these truck deliveries are included in Table 3.2-29 and are expected to be minor.

3.2.4.2.3 Summary of Operational Emission Impacts

As shown in Table 3.2-30, the Expedited BARCT Implementation Schedule would not produce operational emissions that exceed either the Air District's daily or annual criteria pollutant significance thresholds. ROG, CO, NOx, PM_{10} and $PM_{2.5}$ emissions would be less than the applicable significance threshold and, therefore, the associated impacts are concluded to be less than significant.

It should be noted that in addition to the estimated emission increases associated with the operation of new air pollution control equipment under the Expedited BARCT Implementation Schedule, reduction in air emissions would also be expected (see Table 3.2-10). Some of those reductions would be large and are included in Table 3.2-10; however, it is not possible to estimate those emission reductions for all sources, the type of air pollution control device has been identified, appropriate engineering analyses have been completed and so forth. Nonetheless the potential emission increases are expected to be either wholly or partially offset with emission decreases.

TABLE 3.2-30

Worst-Case Operational Emissions Under the AB 617 Expedited BARCT Implementation Schedule

ACTIVITY	ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$
Daily Concurrent Operational Emissions (lb/day)						
15 Oxidizers	2.4	107	13.1	0.2	2.6	2.6
Delivery Trucks for Caustic, Ammonia, and Lime	2.7	0.4	12.5	0.1	0.3	0.1
Total Concurrent Emissions	5.1	107.4	25.6	0.3	2.9	2.7
Reductions from Project Implementation(1)	411	--	--	6,932	--	--
Net Concurrent Emissions(2)	-405.9	107.4	25.6	-6,931.8	2.9	2.7
Significance Thresholds	**54**	**None**	**54**	**None**	**82**	**54**
Significant?	**No**	**--**	**No**	**--**	**No**	**No**
Annual Concurrent Operational Emissions (tons/yr)						
15 Oxidizers	0.4	19.5	2.4	<0.1	0.5	0.5
Delivery Trucks for Caustic, Ammonia, and Lime	0.1	0.1	0.5	0.1	0.1	0.1
Total Concurrent Emissions	0.5	19.5	2.9	0.1	0.6	0.5
Reductions from Project Implementation	75.0	--	--	1,265.0	--	--
Net Concurrent Emissions(2)	-74.5	19.5	2.9	-1,264.9	0.6	0.5
Significance Thresholds	**10**	**None**	**10**	**None**	**15**	**10**
Significant?	**No**	**--**	**No**	**--**	**No**	**No**

(1) See Table 3.2-10. Assumes 365 days of operations.
(2) Negative numbers indicate emission benefit.

3.2.4.3 Potential Toxic Air Contaminant Impacts

Table 3.2-31 shows air pollution control technologies that would be the most likely technologies installed at affected facilities under the Expedited BARCT Implementation Schedule that may have the potential to generate TAC emission impacts during operation. The subsections below evaluate those air pollution control technologies identified in Table 3.2-31 that have the potential to generate adverse TAC emission impacts. Air pollution control technologies where no direct increase or reduce operational TAC emission impacts were identified will not be discussed further.

TABLE 3.2-31

Potential TAC Impacts from Installing Air Pollution Control Equipment

Potential Control Technology	TAC Impacts
Oxidizers	Reduction in TAC emissions
Domes	Reduction in TAC emissions
Lime Injection	No increase in TAC emissions (calcium oxide)
SCR	Increase in TAC emissions (ammonia)
LoTOX™ System	Increase in TAC emissions (caustic)
WGS	Increase in TAC emissions (caustic)
ESP	Potential Increase in TAC emissions (ammonia)

3.2.4.3.1 Wet Gas and LoTOX™ Scrubbers

There are several types of caustic solutions that can be used in WGS or LoTOX™ operations, but NaOH (50 percent solution, by weight) is the one most commonly used. NaOH is a TAC that is a non-cancerous, but an acutely hazardous substance. NaOH emissions typically occur as a result of filling loss and the working loss of each NaOH tank, resulting in relatively low NaOH emissions. Because it is assumed that refinery operators would opt to use the same type of caustic that they are currently using for other purposes, there would likely be a small incremental increase in risk because of the increased throughput of caustic through the existing storage tanks. However, because NaOH is typically diluted and used in small quantities, the combined filling loss and working loss would be small. In addition, any NaOH storage tanks would likely be located in the interior areas of a refinery, so the distance to the nearest sensitive receptive would likely be far enough away that substantial dispersion of any NaOH emission would occur. Table 3.2-32 shows the level of NaOH working losses at a receptor located 25 meters from the unit.

TABLE 3.2-32

NaOH Working Losses

Projected Increase in NaOH Demand (tons/day)	A: Hourly NaOH (as PM_{10}) Filling Loss (lb/hr)	B: Hourly NaOH (as PM_{10}) Working Loss (lb/hr)	A + B = Total Hourly NaOH (as PM_{10}) Losses (lb/hr)	NaOH Acute Level at 25 meters (lb/hr)
3.37	7.60E-04	2.28E-03	2.28E-03	2.28E-05

See Appendix B for calculation methodology.

As indicated in Table 3.2-32, the rate of NaOH working loss emissions would be relatively low for any scrubber unit. Since it is likely that only one tank would be used to store the NaOH solution at each affected facility, working loss concentrations would not overlap. As such, even with multiple NaOH storage tanks, it is not expected that working loss emissions would exceed the acute and chronic hazard indices. For these reasons, it is unlikely that NaOH emissions would create significant adverse acute or chronic hazard impacts to any nearby sensitive receptors. Further, there is an alternative to using NaOH as the caustic solution, sodium carbonate (Na_2CO_3) which is commonly known as soda ash, a non-toxic, non-cancerous, and nonhazardous substance.

The analysis for caustic lime would be expected to be similar as NaOH, also a caustic material. Lime is currently used at the cement plant and additional lime could be used under the Expedited BARCT requirements. Lime is not a TAC regulated by OEHHA. Therefore, the additional use of lime would not generated additional TAC emissions for the cement kiln.

3.2.4.3.2 Selective Catalytic Reduction

Unreacted ammonia emissions generated from SCR units are referred to as ammonia slip. BARCT for ammonia slip is limited to five parts per million (ppm) and enforced by a specific permit condition. Modeling has been performed that shows the concentration of ammonia at a receptor located 25 meters from a stack would be much less than one percent of the concentration at the release from the exit of the stack (SCAQMD, 2015b)[4]. Thus, the peak concentration of ammonia at a receptor located 25 meters from a stack is calculated by assuming a dispersion of one percent. While ammonia does not have an OEHHA approved cancer potency value, it does have non-carcinogenic chronic (200 µg/m3) and acute (3,200 µg/m3) reference exposure levels (RELs). Table 3.2-33 summarizes the calculated non-carcinogenic chronic and acute hazard indices for ammonia and compared these values to the respective significance thresholds; both were shown to be less than significant. Therefore, non-cancer health risks would be less than the acute and chronic hazard indices and associated impacts would be less than significant. This would also be true if ammonia was used as a conditioner for an ESP.

TABLE 3.2-33

Ammonia Slip Calculation

Ammonia Slip Conc. at the Exit of the Stack, ppm(1)	Dispersion Factor(2)	Molecular Weight, g/mol	Peak Conc. at a Receptor 25 m from the Stack, ug/m3	Acute REL, ug/m3	Chronic REL, ug/m3	Acute Hazard Index(3)	Chronic Hazard Index(3)
5	0.01	17.03	35	3,200	200	0.01	0.17

(1) Assumes ammonia slip is limited to five ppm by permitting.
(2) Assumes that the concentration at a receptor 25 m from a stack would be much less than one percent of the concentration at the release from the exist of the stack (SCAQMD, 2015a). The dispersion factor is based on local meteorology.
(3) Hazard index = conc. at receptor 25 m from stack, ug/m3/REL, ug/m3

[4] It is expected that concentrations at 25 meters in the Bay Area would be comparable or less than in southern California because the different meteorological conditions in southern California compared to the Bay Area.

3.2.4.3.3 Summary of TAC Emission Impacts

In general, it should be noted that in addition to the estimated TAC emission increases associated with the operation of new air pollution control equipment, a reduction in TAC emissions would also be expected. The proposed Expedited BARCT Schedule would result in reductions in ROG associated with control on organic liquid storage tanks, petroleum wastewater treating, and fugitive emissions from heavy liquid leaks at refineries. A portion of the ROG emissions associated with ROG emissions may also be TAC emissions. OEHHA has compiled a comprehensive list of 188 chemicals that have been reported to be emitted from California refineries. The ten highest routine emissions from California refineries include ammonia, formaldehyde, methanol, sulfuric acid, hydrogen sulfide, toluene, xylenes, benzene, hexane, and hydrogen chloride. The refinery processes and equipment associated with the most chemical emissions were product loading, fluid catalytic cracking units, heaters, cokers, and vents. The chemicals released in the majority of the processes were phenol, naphthalene, benzene, and toluene (OEHHA, 2017).

OEHHA also calculated the toxicity-weighted score for refinery emissions using the emissions data (pounds emitted per year) and a toxicity weight derived from the U.S. EPA’s Inhalation Toxicity Scores for individual chemicals. The chemicals emitted from refineries in California with the highest calculated toxicity-weighted emissions are: formaldehyde, nickel, arsenic, cadmium, benzene, polycyclic aromatic hydrocarbons, hexavalent chromium, benzo(a)pyrene, phenanthrene, beryllium, ammonia, 1,3-butadiene, naphthalene, hydrogen sulfide, acetaldehyde, manganese, and diethanolamine. Gases make up the majority of the routine refinery TAC emissions (OEHHA, 2017).

However, it is not possible to estimate the potential TAC emissions reductions at this point until the sources that will be controlled are known and the appropriate engineering analyses have been completed and so forth. Nonetheless, air pollution control equipment installed to control ROG emissions as a result of the proposed project is expected to result in a reduction in TAC emissions from affected facilities. Further, the identified TAC emission increases are less than the CEQA significance thresholds. Therefore, TAC emissions associated with the proposed project are expected to result in less than significant impacts.

3.2.4.4 Conclusion

Based on the evaluation of the rule development projects associated with the Expedited BARCT Implementation Schedule and the control equipment that would likely be installed as a result of those projects, construction activities could generate NOx, emissions that exceed the Air District’s construction significance threshold. Therefore, construction air quality impacts are concluded to be significant. Impacts from the operation of air pollution control equipment and methodologies to control criteria pollutant emissions under the Expedited BARCT Implementation Schedule are expected to be less than significant for all criteria pollutant emissions. Further, TAC emissions associated with the proposed project are expected to result in less than significant impacts, with additional reductions in volatile organic TAC emissions.

Additionally, while ROG and SOx emissions show a quantifiable benefit in Table 3.2-30, it is important to remember that the Expedited BARCT Implementation Schedule also expects to achieve NOx, PM_{10}, $PM_{2.5}$, and TAC emissions reductions. While these emissions reductions are difficult to quantify, and thereby not included in Table 3.2-30, the reductions are expected to be substantial and in-line with the goals of AB 617.

3.2.5 MITIGATION MEASURES

3.2.5.1 Construction Mitigation Measures

The proposed project is expected to have significant adverse air quality impacts during the construction phase. Therefore, the following mitigation measures will be imposed on future projects comprised of installing air pollution control equipment to reduce emissions associated with construction activities:

On-Road Mobile Sources:

A-1 Implement measures to minimize emissions from vehicles including, but not limited to, consolidating truck deliveries, prohibiting truck idling in excess of five minutes as contract conditions with carriers and by posting signs onsite, specifying truck routing to minimize congestion emissions, specifying hours of delivery to avoid peak rush-hour traffic, allowing ingress/egress only at specified entry/exit points to avoid heavily congested traffic intersections and streets, and specifying allowable locations of onsite parking.

Off-Road Mobile Sources:

A-2 Prohibit construction equipment from idling longer than five minutes at the facility under consideration as contract conditions with construction companies and by posting signs onsite.

A-3 Maintain construction equipment tuned up and with two- to four-degree retard diesel engine timing or tuned to manufacturer's recommended specifications that optimize emissions without nullifying engine warranties.

A-4 The facility operator shall survey and document the locations of construction areas and identify all construction areas that are served by electricity. Electric welders shall be used in all construction areas that are demonstrated to be served by electricity. Onsite electricity rather than temporary power generators shall be used in all construction areas that are demonstrated to be served by electricity.

A-5 If cranes are required for construction, cranes rated 200 hp or greater equipped with Tier 4 or equivalent engines shall be used. Engines equivalent to Tier 4 may consist of Tier 3 engines retrofitted with diesel particulate filters and oxidation catalysts, selective catalytic reduction, or other equivalent NOx control equipment. Retrofitting cranes rated 200 hp or greater with PM and NOx control devices must occur before the start of construction. If cranes rated 200 hp or greater equipped with Tier 4 engines are not available or cannot be retrofitted with PM and NOx control devices, the facility operator shall use cranes rated 200 hp or greater equipped with Tier 3 or equivalent engines. The facility operator shall provide documentation as information becomes available that cranes rated 200 hp or greater equipped with Tier 4 or equivalent engines are not available.

A-6 For off-road construction equipment rated 50 to 200 hp that will be operating for eight hours or more, the facility operator shall use equipment rated 50 to 200 hp equipped with Tier 4 or equivalent engines. Engines equivalent to Tier 4 may consist of Tier 3 engines retrofitted with diesel particulate filters and oxidation catalysts, selective catalytic reduction, or other equivalent NOx control equipment. Retrofitting equipment rated 50 to 200 hp with PM and NOx control devices must occur before the start of construction. If equipment rated 50 to 200 hp equipped with Tier 4 engines is not available or cannot be retrofitted with PM and NOx control devices, the facility operator shall use equipment rated 50 to 200 hp equipped with Tier 3 or equivalent engines. The facility operator shall provide documentation as information becomes available that equipment rated 50 to 200 hp equipped with Tier 4 or equivalent engines are not available.

3.2.5.1.1 Remaining Construction Impacts

In spite of implementing the construction air quality mitigation measures above, emissions from the construction of air pollution control equipment concurrently would be expected to continue to exceed the applicable construction air quality significance thresholds. The largest exceedance of the significance thresholds is caused by NOx emissions from construction activity. As shown in Table 3.2-34, switching from Tier 3 Blue Sky compliant equipment to Tier 4 could reduce NOx emissions by approximately 90 percent for certain equipment. In order to mitigate NOx emission related to construction activities below the significance threshold, the mitigation measures would need to achieve a reduction in NOx emissions of approximately 86 percent. Thus, the strict enforcement of the Tier 4 requirement for all construction equipment could reduce NOx emissions from construction activities to near or below the significance threshold for NOx emissions. However, the availability of Tier 4 equipment is not expected to be 100 percent because of limited inventory, which could be exacerbated by the size of the projects themselves. Further, equipment under 75 horsepower is not required to achieve NOx reductions from Tier 4 equipment. CARB's In-Use Off-Road Diesel Regulation does require fleets to include Tier 4 or retrofit engines; however, this regulation only requires that 10 percent of the fleet meet this Tier 4 standard. A higher percentage of Tier 4 construction equipment may be achievable, but would be subject to constraints of availability, demand, timing, and the need for any specialized equipment. Therefore, it is conservative to assume the mitigation measures that require the use of Tier 4 construction equipment would achieve at least approximately a 10 percent reduction in NOx emissions from construction related activities, but are not likely to achieve an 86 percent reduction in those emissions.

Table 3.2-34

Tier 4 Equipment Potential Mitigation Reductions

Horsepower	CO	HC	NOx	PM
Pre-Tier 4 Emission Factors (lb/hp-hr)				
50 - 99	3.7		3.5	0.18
100 - 174	3.7		3	0.13
175 - 300	2.6	1	3	0.09
Tier 4 Emission Factors (lb/hp-hr)				
50 - 74	3.7		3.5	0.022
75 - 175	3.7	0.14	0.3	0.015
175+	2.6	0.14	0.3	0.015
Approximate Reduction				
50 - 74	0%	NA	0%	88%
75 - 175	0%	NA	90%	88%
175+	0%	86%	90%	83%

Note:
Pre-Tier 4 assumes Blue Sky Series Engines and NMHC+NOx is all NOx.
Federal off-road diesel emission standards.

In spite of implementing the construction air quality mitigation measures above, it is concluded that the installation of two or more types of air pollution control equipment concurrently would continue to exceed the applicable construction air quality significance thresholds and, therefore, impacts from construction emissions would remain significant.

3.2.5.2 Operation Mitigation Measures

Air quality impacts during operation are expected to be less than significant; therefore, no mitigation measures are required.

3.2.6 CUMULATIVE IMPACTS

Pursuant to CEQA Guidelines §15130(a), "An EIR shall discuss cumulative impacts of a project when the project's incremental effect is cumulatively considerable, as defined in Section 15065 (a)(3). Where a lead agency is examining a project with an incremental effect that is not "cumulatively considerable," a lead agency need not consider that effect significant, but shall briefly describe its basis for concluding that the incremental effect is not cumulatively considerable. Further, CEQA Guidelines §15130 requires that an EIR reflect the severity of the cumulative impacts from a proposed project and their likelihood of occurrence, but the discussion need not provide as great detail as is provided for the effects attributable to the project alone. The discussion should be guided by standards of practicality and reasonableness. Cumulative impacts are defined by CEQA as "two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts" (CEQA Guidelines, §15355).

Cumulative impacts are further described as follows:

- The individual effects may be changes resulting from a single project or a number of separate projects. (State CEQA Guidelines §15355(a).
- The cumulative impacts from several projects are the changes in the environment which result from the incremental impact of the project when added to other closely related past, present, and reasonably foreseeable future projects. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time (CEQA Guidelines, §15355(b)).
- A "cumulative impact" consists of an impact that is created as a result of the combination of the project evaluated in the EIR together with other projects causing related impacts. An EIR should not discuss impacts which do not result in part from the project evaluated in the EIR. (CEQA Guidelines, §15130(a)(1)).

3.2.6.1 Criteria Air Pollutants

3.2.6.1.1 Construction Air Quality Impacts

In the analysis of construction air quality impacts, it was concluded that air quality impacts from construction activities would be significant from implementing the proposed project because the potential overlap in construction activities for air pollution control equipment would likely exceed the applicable ROG, NOx, PM_{10}, and $PM_{2.5}$ significance thresholds for construction air quality impacts. Further, it was concluded that, even after implementing mitigation measures, construction air quality impacts would continue to exceed the applicable significance thresholds for construction. These thresholds represent the levels at which a project's individual emissions would result in a cumulatively considerable contribution to the Air District's existing air quality conditions for individual projects (BAAQMD, 2017a). Thus, the air quality impacts due to construction are considered to be cumulatively considerable for ROG, NOx, PM_{10}, and $PM_{2.5}$ emissions pursuant to CEQA Guidelines §15064 (h)(1) and therefore, generate significant adverse cumulative construction air quality impacts. It should be noted, however, that the air quality analysis is a conservative, "worst-case" analysis so the actual construction impacts are not expected to be as great as estimated here. Further, the construction activities are temporary and would be terminated once any future construction activities are completed.

3.2.6.1.2 Operational Air Quality Impacts

As noted above, the Expedited BARCT Implementation Schedule is not expected to generate significant adverse project-specific air quality impacts and is not expected to exceed the applicable significance thresholds. These thresholds represent the levels at which a project's individual emissions would result in a cumulatively considerable contribution to the Air District's existing air quality conditions for individual projects (BAAQMD, 2017a). As a result, air quality impacts from the proposed project are not considered to be cumulatively considerable pursuant to CEQA Guidelines §15064 (h)(1). As discussed above, in addition to the estimated emission increases associated with the operation of new air pollution control equipment under the Expedited BARCT Implementation Schedule, reductions in air emissions would also be expected, some of which are potentially large. However, it is not possible to estimate all of those emission reductions at this point until the type of air pollution control device has been identified, appropriate engineering analyses have been completed and so forth. Nonetheless the potential emission increases are expected to be either wholly or partially offset with emission decreases.

As described in the EIR for the Clean Air Plan (BAAQMD, 2017), air quality within the Bay Area has improved since 1955 when the Air District was created and is projected to continue to improve. This improvement is mainly due to lower-polluting on-road motor vehicles, more stringent regulation of industrial sources, and the implementation of emission reduction strategies by the Air District. This trend towards cleaner air has occurred in spite of continued population growth. The Air District is in attainment of the State and federal ambient air quality standards for CO, NOx, and SO_2.

However, the Bay Area is designated as a non-attainment area for the federal and state 8-hour ozone standard. The State 8-hour standard was exceeded on 6 days in 2017 in the Air District, most frequently in the Eastern District (Livermore, Patterson Pass, and San Ramon) and the Santa Clara Valley (see Table 3.2-2). The federal 8-hour standard was also exceeded on 6 days in 2017. The Air District is unclassified for the federal 24-hour PM_{10} standard and is non-attainment with the State 24-hour PM_{10} standard. Since the District is not in attainment for the federal and state ozone standard, the state 24-hour PM_{10} standard, and the federal 24-hour $PM_{2.5}$ standard, past projects and activities have contributed to the nonattainment air quality impacts that are cumulatively significant.

The 2017 Clean Air Plan contains numerous control measures that the District intends to impose to improve overall air quality in the District. Control measures in the 2017 Clean Air Plan included some of the rules in the Expedited BARCT Implementation Schedule as well as a number of other control measures to control emissions from stationary sources. The 2017 Clean Air Plan is expected to result in overall reductions in ROG, NOx, SOx, and PM emissions, providing an air quality benefit (BAAQMD, 2017). As reported in the Final EIR for the 2017 Clean Air Plan, large emission reductions are expected from implementation of the 2017 Plan including reductions in ROG emissions of 1,596 tons/year; NOx emissions of 2,929 tons/year, SOx emissions of 2,590 tons/year, and $PM_{2.5}$emissions of 503 tons/year (see Table 3.2-21 of the Final EIR, BAAQMD 2017). These emission reductions are expected to help the Bay Area come into compliance or attainment with the federal and state 8-hour ozone standard, the federal and state PM_{10} standards, the federal 24-hour $PM_{2.5}$ standards, and the state 24-hour $PM_{2.5}$ standard, providing both air quality and public health benefits. Emission reductions from the 2017 Plan are expected to far outweigh any potential secondary emission increases associated with implementation of the control measures in the 2017 Clean Air Plan, as well as emission increases from the Expedited BARCT Implementation schedule, providing a beneficial impact on air quality and public health.

3.2.6.2 Toxic Air Contaminants

It was concluded for the analysis of TAC air quality impacts, that TAC emissions from the use of ammonia and caustic, and lime (calcium carbonate) would be minor and less than significant. Because operational TAC emissions do not exceed the applicable cancer and non-cancer health risk significance thresholds, they are not considered to be cumulatively considerable (CEQA Guidelines §15064 (h)(1)) and, therefore are not expected to generate significant adverse cumulative cancer and non-cancer health risk impacts. In addition, reductions in TAC emissions would be expected due to implementation of the proposed project, but those emission reductions and the related health risk benefits cannot be estimated at this time.

CHAPTER 3.3

HAZARDS AND HAZARDOUS MATERIALS

Introduction
Environmental Setting
Regulatory Setting
Significance Thresholds
Environmental Impacts
Mitigation Measures
Cumulative Impacts

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3.3 HAZARDS AND HAZARDOUS MATERIALS

This subchapter of the EIR evaluates the potential hazards and hazardous material impacts associated with the Expedited BARCT Implementation Schedule, which aims to reduce criteria pollutant emissions from industrial sources that currently participate in the GHG Cap-and-Trade system.

As discussed in the Initial Study, in accordance with AB 617, the purpose of the Expedited BARCT Implementation Schedule is to implement rule development projects that utilize BARCT to reduce criteria pollutant emissions from sources participating in the GHG Cap-and-Trade system throughout the Bay Area. The NOP/IS (see Appendix A) evaluated the potential hazard and hazardous materials impacts associated with implementation of the control equipment in the proposed project. The NOP/IS determined that some control measures have the potential to create direct or indirect hazard impacts. For example, control devices may increase the hazards or releases at industrial facilities due to failure of the control equipment, which would then create an increase in potential hazard impacts in the event of an accidental release of hazards materials into the environment. This subchapter evaluates the potential hazards and hazardous materials impacts that could result due to expedited BARCT implementation.

3.3.1 ENVIRONMENTAL SETTING

The potential for hazards exist in the production, use, storage and transportation of hazardous materials. Hazardous materials may be found at industrial production and processing facilities. Some facilities produce hazardous materials as their end product, while others use such materials as an input to their production process. Examples of hazardous materials used as consumer products include gasoline, solvents, and coatings/paints. Hazardous materials are stored at facilities that produce such materials and at facilities where hazardous materials are a part of the production process. Specifically, storage refers to the bulk handling of hazardous materials before and after they are transported to the general geographical area of use. Currently, hazardous materials are transported throughout the district in great quantities via all modes of transportation including rail, highway, water, air, and pipeline.

The potential hazards associated with industrial activities are a function of the materials being processed, processing systems, and procedures used to operate and maintain the facility. The hazards that are likely to exist are identified by the physical and chemical properties of the materials being handled and their process conditions, including the following events:

- **Toxic gas clouds:** Toxic gas clouds are releases of volatile chemicals (e.g., anhydrous ammonia, chlorine, and hydrogen sulfide) that could form a cloud and migrate off-site, thus exposing individuals. "Worst-case" conditions tend to arise when very low wind speeds coincide with an accidental release, which can allow the chemicals to accumulate rather than disperse.

- **Torch fires (gas and liquefied gas releases), flash fires (liquefied gas releases), pool fires, and vapor cloud explosions (gas and liquefied gas releases):** The rupture of a storage tank or vessel containing a flammable gaseous material (like propane or gasoline), without immediate ignition, can result in a vapor cloud explosion. The “worst-case” upset would be a release that produces a large aerosol cloud with flammable properties. If the flammable cloud does not ignite after dispersion, the cloud would simply dissipate. If the flammable cloud were to ignite during the release, a flash fire or vapor cloud explosion could occur. If the flammable cloud were to ignite immediately upon release, a torch fire would ensue.

- **Thermal Radiation:** Thermal radiation is the heat generated by a fire and the potential impacts associated with exposure. Exposure to thermal radiation would result in burns, the severity of which would depend on the intensity of the fire, the duration of exposure, and the distance of an individual to the fire.

- **Explosion/Overpressure:** Process vessels containing flammable explosive vapors and potential ignition sources are present at industrial facilities, e.g., refineries and chemical plants. Explosions may occur if the flammable/explosive vapors came into contact with an ignition source. An explosion could cause impacts to individuals and structures in the area due to overpressure.

3.3.1.1 Hazardous Materials Incidents

The Department of Transportation, Office of Pipeline and Hazardous Materials Safety Administration (PHMSA) utilizes a post incident reporting system that collects data on incidents involving accidents. Information on accidental releases of hazardous materials are reported to PHMSA. PHMSA provides access to retrieve data from the Incident Reports Database, which also includes non-pipeline incidents, e.g., truck and rail events. Incident data and summary statistics, e.g., release date geographical location (state and county) and type of material released, are available online from the Hazmat Incident Database and are summarized in yearly incident summary reports (PHMSA, 2018).

The California Hazardous Materials Incident Reporting System (CHMIRS) is a post incident reporting system to collect data on incidents involving the accidental release of hazardous materials. Information on accidental releases of hazardous materials are reported to and maintained by the California Governor’s Office of Emergency Services (Cal OES). While information on accidental releases is reported to Cal OES, Cal OES no longer conducts statistical evaluations of the releases.

Table 3.3-1 provides a summary of the reported hazardous materials incidents in the nine counties within the Bay Area. In 2017, there were a total of 1,634 incidents reported in the nine counties regulated by the BAAQMD (see Table 3.3-1), with the most incidents (388) reported in Alameda County, followed by Contra Costa County (313).

TABLE 3.3-1

Hazardous Materials Incidents 2017 by County

COUNTY	REPORTED INCIDENTS
Alameda	388
Contra Costa	313
Marin	97
Napa	54
San Francisco	112
San Mateo	140
Santa Clara	189
Solano*	132
Sonoma*	209
Total No. of Reported Incidents	**1,634**

Source: OES, 2018

* Not all of Solano or Sonoma Counties are within the jurisdiction of BAAQMD

The location of the spills varies (see Table 3.3-2). In the nine counties that comprise the Air District, hazardous materials incidents during transportation, residential areas, and at waterways were the most common locations, respectively, for hazardous materials incidents. About 19 percent of the hazardous materials incidents that occurred within California occurred within the nine counties that comprise the Bay Area, with spills in industrial areas being the most common (38 percent), followed by waterways (28 percent).

TABLE 3.3-2

Hazardous Materials Incidents 2017

Spill Site	BAAQMD	Statewide	Percent of State Total
Waterways	250	880	28%
Transportation	463	2,956	16%
Industrial	182	480	38%
Commercial	209	1,191	18%
Residential	279	1,415	20%
Utilities	58	290	20%
Military	4	58	7%
Other	189	1,487	13%
Total	1,634	8,757	19%

Source: OES, 2018

3.3.1.2 Potential Hazards Associated with Air Pollution Control Equipment

The District has evaluated the hazards associated with the implementation of rules in previous air plans (2017 Clean Air Plan) and proposed District rules. The analyses covered a range of potential air pollution control technologies and equipment. EIRs prepared for the previous rules and air plans have specifically evaluated hazard impacts from add-on pollution control equipment. Add on pollution control technologies include scrubbers, bag filters, SCRs, vapor recovery systems, and electrostatic precipitators. The use of add-on pollution control equipment may concentrate or utilize hazardous materials. A malfunction or accident when using add-on pollution control equipment could potentially expose people to hazardous materials, explosions, or fires. The transport, use, and storage of hazardous materials are evaluated herein.

3.3.2 REGULATORY SETTING

There are many federal and state rules and regulations for handling hazardous materials, which serve to minimize the potential impacts associated with hazards.

3.3.2.1 Federal Regulations

The U.S. EPA is the primary federal agency charged with protecting human health and with safeguarding the natural environment from pollution into air, water, and land. The U.S. EPA works to develop and enforce regulations that implement environmental laws enacted by Congress. The U.S. EPA is responsible for researching and setting national standards for a variety of environmental programs, and delegates to states and Indian tribes the responsibility for issuing permits and for monitoring and enforcing compliance. Since 1970, Congress has enacted numerous environmental laws that pertain to hazardous materials, for the U.S. EPA to implement as well as to other agencies at the federal, state and local level, as described in the following subsections.

3.3.2.1.1 Hazardous Materials and Waste Regulations

Resource Conservation and Recovery Act: The Resource Conservation and Recovery Act (RCRA) of 1976 authorizes the U.S. EPA to control the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA considers materials and waste to be hazardous based on four characteristics: ignitability, corrosivity, reactivity, and toxicity. Under RCRA regulations, hazardous wastes must be tracked from the time of generation to the point of disposal. In 1984, RCRA was amended with addition of the Hazardous and Solid Waste Amendments, which authorized increased enforcement by the U.S. EPA, stricter hazardous waste standards, and a comprehensive underground storage tank program. Likewise, the Hazardous and Solid Waste Amendments focused on waste reduction and corrective action for hazardous releases. The use of certain techniques for the disposal of some hazardous wastes was specifically prohibited by the Hazardous and Solid Waste Amendments. Individual states may implement their own hazardous waste programs under RCRA, with approval by the U.S. EPA. California has been delegated authority to operate its own hazardous waste management program.

Comprehensive Environmental Response, Compensation and Liability Act: The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), which is often commonly referred to as Superfund, is a federal statute that was enacted in 1980 to address abandoned sites containing hazardous waste and/or contamination. CERCLA was amended in 1986 by the Superfund Amendments and Reauthorization Act, and by the Small Business Liability Relief and Brownfields Revitalization Act of 2002.

CERCLA contains prohibitions and requirements concerning closed and abandoned hazardous waste sites; establishes liability of persons responsible for releases of hazardous waste at these sites; and establishes a trust fund to provide for cleanup when no responsible party can be identified. The trust fund is funded largely by a tax on the chemical and petroleum industries. CERCLA also provides federal jurisdiction to respond directly to releases or impending releases of hazardous substances that may endanger public health or the environment.

CERCLA also enabled the revision of the National Contingency Plan (NCP) which provided the guidelines and procedures needed to respond to releases and threatened releases of hazardous substances, pollutants, or contaminants. The NCP also established the National Priorities List, which identifies hazardous waste sites eligible for long-term remedial action financed under the federal Superfund program.

Prevention of Accidental Releases and Risk Management Programs: Requirements pertaining to the prevention of accidental releases are promulgated in §112 (r) of the CAA Amendments of 1990 [42 U.S.C. §7401 et. seq.]. The objective of these requirements was to prevent the accidental release and to minimize the consequences of any such release of a hazardous substances. Under these provisions, facilities that produce, process, handle or store hazardous substances have a duty to: 1) identify hazards which may result from releases using hazard assessment techniques; 2) design and maintain a safe facility and take steps necessary to prevent releases; and, 3) minimize the consequence of accidental releases that occur.

In accordance with the requirements in §112 (r), U.S. EPA adopted implementing guidelines in 40 CFR Part 68. Under this part, stationary sources with more than a threshold quantity of a regulated substance shall be evaluated to determine the potential for and impacts of accidental releases from any processes subject to the federal risk management requirements. Under certain conditions, the owner or operator of a stationary source may be required to develop and submit a Risk Management Plan (RMP). RMPs consist of three main elements: a hazard assessment that includes off-site consequences analyses and a five-year accident history, a prevention program, and an emergency response program. At the local level, RMPs are implemented by the local fire departments.

3.3.2.1.2 Emergency Planning and Community Right-to-Know Act

The Emergency Planning and Community Right-to-Know Act (EPCRA) is a federal law adopted by Congress in 1986 that is designed to help communities plan for emergencies involving hazardous substances. EPCRA establishes requirements for federal, state and local governments, Indian tribes, and industry regarding emergency planning and "Community Right-to-Know" reporting on hazardous and toxic chemicals. The Community Right-to-Know provisions help increase the public's knowledge and access to information on chemicals at individual facilities, their uses, and releases into the environment. States and communities, working with facilities, can use the information to improve chemical safety and protect public health and the environment. There are four major provisions of EPCRA:

1. Emergency Planning (§§301 – 303) requires local governments to prepare chemical emergency response plans, and to review plans at least annually. These sections also require state governments to oversee and coordinate local planning efforts. Facilities that maintain Extremely Hazardous Substances (EHS) onsite (see 40 CFR Part 355 for the list of EHS chemicals) in quantities greater than corresponding "Threshold Planning Quantities" must cooperate in the preparation of the emergency plan.

2. Emergency Release Notification (§304) requires facilities to immediately report accidental releases of EHS chemicals and hazardous substances in quantities greater than corresponding Reportable Quantities (RQs) as defined under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to state and local officials. Information about accidental chemical releases must be made available to the public.

3. Hazardous Chemical Storage Reporting (§§311 – 312) requires facilities that manufacture, process, or store designated hazardous chemicals to make Safety Data Sheets (SDSs, formerly referred to as material safety data sheets or MSDSs) describing the properties and health effects of these chemicals available to state and local officials and local fire departments. These sections also require facilities to report to state and local officials and local fire departments, inventories of all onsite chemicals for which SDSs exist. Lastly, information about chemical inventories at facilities and SDSs must be available to the public.

4. Toxic Chemical Release Inventory (§313) requires facilities to annually complete and submit a Toxic Chemical Release Inventory Form for each Toxic Release Inventory (TRI) chemical that are manufactured or otherwise used above the applicable threshold quantities.

Implementation of EPCRA has been delegated to the State of California. The California Emergency Management Agency requires facilities to develop a Hazardous Materials Business Plan if they handle hazardous materials in quantities equal to or greater than 55 gallons, 500 pounds, or 200 cubic feet of gas or extremely hazardous substances above the threshold planning quantity. The Hazardous Materials Business Plan is provided to state and local emergency response agencies and includes inventories of hazardous materials, an emergency plan, and implements a training program for employees.

3.3.2.1.3 Hazardous Materials Transportation Act

The Hazardous Material Transportation Act (HMTA), adopted in 1975 (see 49 U.S.C. §§5101 – 5127), gave the Secretary of Transportation the regulatory and enforcement authority to provide adequate protection against the risks to life and property inherent in the transportation of hazardous materials in commerce. The U.S. DOT (see 49 CFR Parts 171-180) oversees the movement of hazardous materials at the federal level. The HMTA requires that carriers report accidental releases of hazardous materials to U.S. DOT at the earliest practical moment. Other incidents that must be reported include deaths, injuries requiring hospitalization, and property damage exceeding $50,000. The hazardous material regulations also contain emergency response provisions which include incident reporting requirements. Reports of major incidents go to the National Response Center, which in turn is linked with CHEMTREC, a public service hotline established by the chemical manufacturing industry for emergency responders to obtain information and assistance for emergency incidents involving chemicals and hazardous materials.

Hazardous materials regulations are implemented by the Research and Special Programs Administration (RSPA) branch of the U.S. DOT. The regulations cover the definition and classification of hazardous materials, communication of hazards to workers and the public, packaging and labeling requirements, operational rules for shippers, and training. These regulations apply to interstate, intrastate, and foreign commerce by air, rail, ships, and motor vehicles, and also cover hazardous waste shipments. The Federal Aviation Administration Office of Hazardous Materials Safety is responsible for overseeing the safe handling of hazardous materials aboard aircraft. The Federal Railroad Administration oversees the transportation of hazardous materials by rail. The U.S. Coast Guard regulates the bulk transport of hazardous materials by sea. The Federal Highway Administration (FHWA) is responsible for highway routing of hazardous materials and issuing highway safety permits.

3.3.2.1.4 Toxic Substances Control Act

The Toxic Substances Control Act (TSCA) was enacted by Congress in 1976 (see 15 U.S.C. §2601 et seq.) and gave the U.S. EPA the authority to protect the public from unreasonable risk of injury to health or the environment by regulating the manufacture, sale, and use of chemicals currently produced or imported into the United States. The TSCA, however, does not address wastes produced as byproducts of manufacturing. The types of chemicals regulated by the act fall into two categories: existing and new. New chemicals are defined as “any chemical substance which is not included in the chemical substance list compiled and published under [TSCA] section 8(b).” This list included all of chemical substances manufactured or imported into the U.S. prior to December 1979. Existing chemicals include any chemical currently listed under section 8 (b). The distinction between existing and new chemicals is necessary as the act regulates each category of chemicals in different ways. The U.S. EPA repeatedly screens both new and existing chemicals and can require reporting or testing of those that may pose an environmental or human-health hazard. The U.S. EPA can ban the manufacture and import of those chemicals that pose an unreasonable risk.

3.3.2.1.5 Hazardous Material Worker and Public Safety Requirements

Occupational Safety and Health Administration Regulations: The federal Occupational Safety and Health Administration (OSHA) is an agency of the United States Department of Labor that was created by Congress under the Occupational Safety and Health Act in 1970. OSHA is the agency responsible for assuring worker safety in the handling and use of chemicals in the workplace. Under the authority of the Occupational Safety and Health Act of 1970, OSHA has adopted numerous regulations pertaining to worker safety (see 29 CFR Part 1910). These regulations set standards for safe workplaces and work practices, including the reporting of accidents and occupational injuries. Some OSHA regulations contain standards relating to hazardous materials handling to protect workers who handle toxic, flammable, reactive, or explosive materials, including workplace conditions, employee protection requirements, first aid, and fire protection, as well as material handling and storage. For example, facilities which use, store, manufacture, handle, process, or move hazardous materials are required to conduct employee safety training, have available and know how to use safety equipment, prepare illness prevention programs, provide hazardous substance exposure warnings, prepare emergency response plans, and prepare a fire prevention plan.

Procedures and standards for safe handling, storage, operation, remediation, and emergency response activities involving hazardous materials and waste are promulgated in 29 CFR Part 1910, Subpart H. Some key subsections in 29 CFR Part 1910, Subpart H are §1910.106 - Flammable Liquids and §1910.120 - Hazardous Waste Operations and Emergency Response. In particular, the Hazardous Waste Operations and Emergency Response regulations contain requirements for worker training programs, medical surveillance for workers engaging in the handling of hazardous materials or wastes, and waste site emergency and remediation planning, for those who are engaged in specific clean-up, corrective action, hazardous material handling, and emergency response activities (see 29 CFR Part 1910 Subpart H, §1910.120 (a)(1)(i-v) and §1926.65 (a)(1)(i-v)).

Process Safety Management: As part of the numerous regulations pertaining to worker safety adopted by OSHA, specific requirements that pertain to Process Safety Management (PSM) of Highly Hazardous Chemicals were adopted in 29 CFR Part 1910 Subpart H, §1910.119 and 8 CCR §5189 to protect workers at facilities that have toxic, flammable, reactive or explosive materials. PSM program elements are aimed at preventing or minimizing the consequences of catastrophic releases of chemicals and include process hazard analyses, formal training programs for employees and contractors, investigation of equipment mechanical integrity, and an emergency response plan. Specifically, the PSM program requires facilities that use, store, manufacture, handle, process, or move hazardous materials to conduct employee safety training; have an inventory of safety equipment relevant to potential hazards; have knowledge on the use of the safety equipment; prepare an illness prevention program; provide hazardous substance exposure warnings; prepare an emergency response plan; and prepare a fire prevention plan.

Emergency Action Plan: An Emergency Action Plan (EAP) is a written document required by OSHA standards promulgated in 29 CFR Part 1910, Subpart E, §1910.38 (a) to facilitate and organize a safe employer and employee response during workplace emergencies. An EAP is required by all that are required to have fire extinguishers. At a minimum, an EAP must include the following: 1) a means of reporting fires and other emergencies; 2) evacuation procedures and emergency escape route assignments; 3) procedures to be followed by employees who remain to operate critical plant operations before they evacuate; 4) procedures to account for all employees after an emergency evacuation has been completed; 5) rescue and medical duties for those employees who are to perform them; and, 6) names or job titles of persons who can be contacted for further information or explanation of duties under the plan.

National Fire Regulations: The National Fire Codes (NFC), Title 45, published by the National Fire Protection Association (NFPA) contains standards for laboratories using chemicals, which are not requirements, but are generally employed by organizations in order to protect workers. These standards provide basic protection of life and property in laboratory work areas through prevention and control of fires and explosions, and also serve to protect personnel from exposure to non-fire health hazards.

In addition to the NFC, the NFPA adopted a hazard rating system which is promulgated in NFPA 704 - Standard System for the Identification of the Hazards of Materials for Emergency Response. NFPA 704 is a "standard (that) provides a readily recognized, easily understood system for identifying specific hazards and their severity using spatial, visual, and numerical methods to describe in simple terms the relative hazards of a material. It addresses the health, flammability, instability, and related hazards that may be presented as short-term, acute exposures that are most likely to occur as a result of fire, spill, or similar emergency." In addition, the hazard ratings per NFPA 704 are used by emergency personnel to quickly and easily identify the risks posed by nearby hazardous materials in order to help determine what, if any, specialty equipment should be used, procedures followed, or precautions taken during the first moments of an emergency response. The scale is divided into four color-coded categories, with blue indicating level of health hazard, red indicating the flammability hazard, yellow indicating the chemical reactivity, and white containing special codes for unique hazards such as corrosivity and radioactivity. Each hazard category is rated on a scale from 0 (no hazard; normal substance) to 4 (extreme risk). Table 3.3-3 summarizes what the codes mean for each hazards category.

In addition to the information in Table 3.3-3, a number of other physical or chemical properties may cause a substance to be a fire hazard. With respect to determining whether any substance is classified as a fire hazard, SDS lists the NFPA 704 flammability hazard ratings (e.g., NFPA 704).

Although substances can have the same NFPA 704 Flammability Ratings Code, other factors can make each substance's fire hazard very different from each other. For this reason, additional chemical characteristics, such as auto-ignition temperature, boiling point, evaporation rate, flash point, lower explosive limit (LEL), upper explosive limit (UEL), and vapor pressure, are also considered when determining whether a substance is fire hazard. The following is a brief description of each of these chemical characteristics.

> <u>Auto-ignition Temperature:</u> The auto-ignition temperature of a substance is the lowest temperature at which it will spontaneously ignite in a normal atmosphere without an external source of ignition, such as a flame or spark.
>
> <u>Boiling Point:</u> The boiling point of a substance is the temperature at which the vapor pressure of the liquid equals the environmental pressure surrounding the liquid. Boiling is a process in which molecules anywhere in the liquid escape, resulting in the formation of vapor bubbles within the liquid.

TABLE 3.3-3

NFPA 704 Hazards Rating Code

Hazard Rating Code	Health (Blue)	Flammability (Red)	Reactivity (Yellow)	Special (White)
4 = Extreme	Very short exposure could cause death or major residual injury (extreme hazard).	Will rapidly or completely vaporize at normal atmospheric pressure and temperature, or is readily dispersed in air and will burn readily. Flash point below 73°F.	Readily capable of detonation or explosive decomposition at normal temperatures and pressures.	W = Reacts with water in an unusual or dangerous manner.
3 = High	Short exposure could cause serious temporary or moderate residual injury.	Liquids and solids that can be ignited under almost all ambient temperature conditions. Flash point between 73°F and 100°F.	Capable of detonation or explosive decomposition but requires a strong initiating source, must be heated under confinement before initiation, reacts explosively with water, or will detonate if severely shocked.	**OXY** = Oxidizer
2 = Moderate	Intense or continued but not chronic exposure could cause temporary incapacitation or possible residual injury.	Must be moderately heated or exposed to relatively high ambient temperature before ignition can occur. Flash point between 100°F and 200°F.	Undergoes violent chemical change at elevated temperatures and pressures, reacts violently with water, or may form explosive mixtures with water.	**SA** = Simple asphyxiant gas (includes nitrogen, helium, neon, argon, krypton, and xenon).
1 = Slight	Exposure would cause irritation with only minor residual injury.	Must be heated before ignition can occur. Flash point over 200°F.	Normally stable, but can become unstable at elevated temperatures and pressures.	Not applicable
0 = Insignificant	Poses no health hazard, no precautions necessary.	Will not burn.	Normally stable, even under fire exposure conditions, and is not reactive with water.	Not applicable

<u>Evaporation Rate:</u> Evaporation rate is the rate at which a material will vaporize (evaporate, change from liquid to a vapor) compared to the rate of vaporization of a specific known material. This quantity is a represented as a unit less ratio. For example, a substance with a high evaporation rate will readily form a vapor which can be inhaled or explode, and thus have a higher hazard risk. Evaporation rates generally have an inverse relationship to boiling points (i.e., the higher the boiling point, the lower the rate of evaporation).

<u>Flash Point:</u> Flash point is the lowest temperature at which a volatile liquid can vaporize to form an ignitable mixture in air. Measuring a liquid's flash point requires an ignition source. At the flash point, the vapor may cease to burn when the source of ignition is removed. There are different methods that can be used to determine the flashpoint of a

solvent but the most frequently used method is the Tagliabue Closed Cup standard (ASTM D56), also known as the TCC. The flashpoint is determined by a TCC laboratory device which is used to determine the flash point of mobile petroleum liquids with flash point temperatures below 175 degrees Fahrenheit (79.4 degrees Centigrade).

Flash point is a particularly important measure of the fire hazard of a substance. For example, the Consumer Products Safety Commission (CPSC) promulgated Labeling and Banning Requirements for Chemicals and Other Hazardous Substances in 15 U.S.C. §1261 and 16 CFR Part 1500. Per the CPSC, the flammability of a product is defined in 16 CFR Part 1500.3 (c)(6) and is based on flash point. For example, a liquid needs to be labeled as: 1) “Extremely Flammable” if the flash point is below 20 degrees Fahrenheit; 2) “Flammable” if the flash point is above 20 degrees Fahrenheit but less than 100 degrees Fahrenheit; or, 3) “Combustible” if the flash point is above 100 degrees Fahrenheit up to and including 150 degrees Fahrenheit.

<u>Lower Explosive Limit (LEL):</u> The lower explosive limit of a gas or a vapor is the limiting concentration (in air) that is needed for the gas to ignite and explode or the lowest concentration (percentage) of a gas or a vapor in air capable of producing a flash of fire in presence of an ignition source (e.g., arc, flame, or heat). If the concentration of a substance in air is below the LEL, there is not enough fuel to continue an explosion. In other words, concentrations lower than the LEL are "too lean" to burn. For example, methane gas has a LEL of 4.4 percent (at 138 degrees Centigrade) by volume, meaning 4.4 percent of the total volume of the air consists of methane. At 20 degrees Centigrade, the LEL for methane is 5.1 percent by volume. If the atmosphere has less that 5.1 percent methane, an explosion cannot occur even if a source of ignition is present. When the concentration of methane reaches 5.1 percent, an explosion can occur if there is an ignition source.

<u>Upper Explosive Limit (UEL):</u> The upper explosive limit of a gas or a vapor is the highest concentration (percentage) of a gas or a vapor in air capable of producing a flash of fire in presence of an ignition source (e.g., arc, flame, or heat). Concentrations of a substance in air above the UEL are "too rich" to burn.

<u>Vapor Pressure:</u> Vapor pressure is an indicator of a chemical’s tendency to evaporate into gaseous form.

Health Hazards Guidance: In addition to fire impacts, health hazards can also be generated due to exposure of chemicals present in products, by-products and wastes. As a measure of a chemical’s potential health hazards, the following values need to be considered: the Threshold Limit Values established by the American Conference of Governmental Industrial Hygiene, OSHA’s Permissible Exposure Limits, the Immediately Dangerous to Life and Health levels recommended by the National Institute for Occupational Safety and Health (NIOSH), and health hazards developed by the National Safety Council. The following is a brief description of each of these values.

Threshold Limit Values (TLVs): The TLV of a chemical substance is a level to which it is believed a worker can be exposed day after day for a working lifetime without adverse health effects. The TLV is an estimate based on the known toxicity in humans or animals of a given chemical substance, and the reliability and accuracy of the latest sampling and analytical methods. The TLV for chemical substances is defined as a concentration in air, typically for inhalation or skin exposure. Its units are in parts per million (ppm) for gases and in milligrams per cubic meter (mg/m^3) for particulates. The TLV is a recommended guideline by the American Conference of Governmental Industrial Hygienists (ACGIH).

Permissible Exposure Limits (PEL): The PEL is a legal limit, usually expressed in ppm, established by OSHA to protect workers against the health effects of exposure to hazardous substances. PELs are regulatory limits on the amount or concentration of a substance in the air. A PEL is usually given as a time-weighted average (TWA), although some are short-term exposure limits (STEL) or ceiling limits. A TWA is the average exposure over a specified period of time, usually eight hours. This means that, for limited periods, a worker may be exposed to concentrations higher than the PEL, so long as the average concentration over eight hours remains lower. A short-term exposure limit is one that addresses the average exposure over a 15 to 30 minute period of maximum exposure during a single work shift. A ceiling limit is one that may not be exceeded for any period of time, and is applied to irritants and other materials that have immediate effects. The OSHA PELs are published in 29 CFR 1910.1000, Table Z1.

Immediately Dangerous to Life and Health (IDLH): IDLH is an acronym defined by NIOSH as exposure to airborne contaminants that is "likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment." IDLH values are often used to guide the selection of breathing apparatus that are made available to workers or firefighters in specific situations.

3.3.2.1.6 Oil and Pipeline Regulations and Oversight

Oil Pollution Act: The Oil Pollution Act was signed into law in 1990 to give the federal government authority to better respond to oil spills. The Oil Pollution Act improved the federal government's ability to prevent and respond to oil spills, including provision of money and resources. The Oil Pollution Act establishes polluter liability, gives states enforcement rights in navigable waters of the state, mandates the development of spill control and response plans for all vessels and facilities, increases fines and enforcement mechanisms, and establishes a federal trust fund for financing clean-up.

The Oil Pollution Act also establishes the National Oil Spill Liability Trust Fund to provide financing for cases in which the responsible party is either not readily identifiable, or refuses to pay the cleanup/damage costs. In addition, the Oil Pollution Act expands provisions of the National Oil and Hazardous Substances Pollution Contingency Plan, more commonly called the National Contingency Plan, requiring the federal government to direct all public and private oil spill response efforts. It also requires area committees, composed of federal, state, and local government officials, to develop detailed, location-specific area contingency plans. In addition, the Oil Pollution Act directs owners and operators of vessels, and certain facilities that pose a serious threat to the environment, to prepare their own specific facility response plans. The Oil Pollution Act increases penalties for regulatory non-compliance by responsible parties; gives the federal government broad enforcement authority; and provides individual states the authority to establish their own laws governing oil spills, prevention measures, and response methods.

Oil Pollution Prevention Regulation: In 1973, the U.S. EPA issued the Oil Pollution Prevention regulation (see 40 CFR 112)**,** to address the oil spill prevention provisions contained in the Clean Water Act of 1972. The Spill Prevention, Control, and Countermeasure (SPCC) Rule is part of the Oil Pollution Prevention regulations (see 40 CFR Part 112, Subparts A - C). Specifically, the SPCC rule includes requirements for oil spill prevention, preparedness, and response to prevent oil discharges to navigable waters and adjoining shorelines. The rule requires specific facilities to prepare, amend, and implement SPCC Plans. SPCC Plans require applicable facilities to take steps to prevent oil spills including: 1) using suitable storage containers/tanks; 2) providing overfill prevention (e.g., high-level alarms); 3) providing secondary containment for bulk storage tanks; 4) providing secondary containment to catch oil spills during transfer activities; and, 5) periodically inspecting and testing pipes and containers.

U.S. Department of Transportation, Office of Pipeline Safety: The Office of Pipeline Safety, within the U.S. DOT, Pipeline and Hazards Material Safety Administration, has jurisdictional responsibility for developing regulations and standards to ensure the safe and secure movement of hazardous liquid and gas pipelines under its jurisdiction in the United States. The Office of Pipeline Safety has the following key responsibilities:

- Support the operation of, and coordinate with the United States Coast Guard on the National Response Center and serve as a liaison with the Department of Homeland Security and the Federal Emergency Management Agency on matters involving pipeline safety;

- Develop and maintain partnerships with other federal, state, and local agencies, public interest groups, tribal governments, and the regulated industry and other underground utilities to address threats to pipeline integrity, service, and reliability and to share responsibility for the safety of communities;

- Administer pipeline safety regulatory programs and develops regulatory policy involving pipeline safety;

- Oversee pipeline operator implementation of risk management and risk-based programs and administer a national pipeline inspection and enforcement program;

- Provide technical and resource assistance for state pipeline safety programs to ensure oversight of intrastate pipeline systems and educational programs at the local level; and,

- Support the development and conduct of pipeline safety training programs for federal and state regulatory and compliance staff and the pipeline industry.

49 CFR Parts 178 – 185 relates to the role of transportation, including pipelines, in the United States. 49 CFR Parts 186-199 establishes minimum pipeline safety standards. The Office of the State Fire Marshal works in partnership with the Federal Pipeline and Hazardous Materials Safety Administration to assure pipeline operators are meeting requirements for safe, reliable, and environmentally sound operation of their facilities for intrastate pipelines within California.

Chemical Facility Anti-Terrorism Standards: The Federal Department of Homeland Security established the chemical facility anti-terrorism standards in 2007 (see 6 CFR Part 27). These regulations established risk-based performance standards for the security of chemical facilities and require covered chemical facilities to prepare Security Vulnerability Assessments, which identify facility security vulnerabilities, and to develop and implement security plans.

3.3.2.2 State Regulations

California Hazardous Waste Control Law: The California Hazardous Waste Control Law is administered by the California Environmental Protection Agency (CalEPA) to regulate hazardous wastes within the State of California. While the California Hazardous Waste Control Law is generally more stringent than RCRA, both the state and federal laws apply in California. The California Department of Toxic Substances Control (DTSC) is the primary agency in charge of enforcing both the federal and state hazardous materials laws in California. The DTSC regulates hazardous waste, oversees the cleanup of existing contamination, and pursues methods to reduce hazardous waste produced in California. The DTSC regulates hazardous waste in California under the authority of RCRA, the California Hazardous Waste Control Law, and the California Health and Safety Code. Under the direction of the CalEPA, the DTSC maintains the Cortese List and Envirostor databases of hazardous materials and waste sites as specified under Government Code §65962.5.

The Hazardous Waste Control Law (22 CCR Chapter 11, Appendix X) also lists 791 chemicals and approximately 300 common materials which may be hazardous; establishes criteria for identifying, packaging, and labeling hazardous wastes; prescribes management controls; establishes permit requirements for treatment, storage, disposal, and transportation; and identifies some wastes that cannot be disposed of in landfills.

California Occupational Safety and Health Administration: The California Occupational Safety and Health Administration (CalOSHA) is the primary agency responsible for worker safety in the handling and use of chemicals in the workplace. CalOSHA requires the employer to monitor worker exposure to listed hazardous substances and notify workers of exposure (8 CCR Sections 337-340). The regulations specify requirements for employee training, availability of safety equipment, accident-prevention programs, and hazardous substance exposure warnings. CalOSHA standards are generally more stringent than federal regulations.

Hazardous Materials Release Notification: Many state statutes require emergency notification of a hazardous chemical release, including:

- California Health and Safety Code §25270.7, §25270.8, and §25507;

- California Vehicle Code §23112.5;
- California Public Utilities Code §7673 (General Orders #22-B, 161);
- California Government Code §51018 and §8670.25.5(a);
- California Water Code §13271 and §13272; and,
- California Labor Code §6409.1(b)10.

California Accident Release Prevention (CalARP) Program: The California Accident Release Prevention Program (19 CCR Division 2, Chapter 4.5) requires the preparation of RMPs. CalARP requires stationary sources with more than a threshold quantity of a regulated substance to be evaluated to determine the potential for and impacts of accidental releases from any processes onsite (not transportion) subject to state risk management requirements. RMPs are documents prepared by the owner or operator of a stationary source containing detailed information including: (1) regulated substances held onsite at the stationary source; (2) offsite consequences of an accidental release of a regulated substance; (3) the accident history at the stationary source; (4) the emergency response program for the stationary source; (5) coordination with local emergency responders; (6) hazard review or process hazard analysis; (7) operating procedures at the stationary source; (8) training of the stationary source's personnel; (9) maintenance and mechanical integrity of the stationary source's physical plant; and (10) incident investigation. The CalARP program is implemented at the local government level by Certified Unified Program Agencies (CUPAs) also known as Administering Agencies (AAs). Typically, local fire departments are the administering agencies of the CalARP program because they frequently are the first responders in the event of a release. The CalARP regulations were last updated in October 2017 to include new Program 4 requirements.

Hazardous Materials Disclosure Program: The Unified Hazardous Waste and Hazardous Materials Management Regulatory Program (Unified Program) as promulgated by CalEPA in CCR, Title 27, Chapter 6.11 requires the administrative consolidation of six hazardous materials and waste programs (program elements) under one agency, a CUPA. The Unified Program administered by the State of California consolidates, coordinates, and makes consistent the administrative requirements, permits, inspections, and enforcement activities for the state's environmental and emergency management programs, which include Hazardous Waste Generator and Onsite Hazardous Waste Treatment Programs ("Tiered Permitting"); Above ground SPCC Program; Hazardous Materials Release Response Plans and Inventories (business plans); the CalARP Program; the UST Program; and the Uniform Fire Code Plans and Inventory Requirements. The Unified Program is implemented at the local government level by CUPAs.

Hazardous Materials Management Act: The State of California (California Health and Safety Code Division 20, Chapter 6.95) requires any business that handles more than a specified amount of hazardous or extremely hazardous materials, termed a "reportable quantity," to submit a Hazardous Materials Business Plan to its Certified Unified Program Agency. Business plans must include an inventory of the types, quantities, and locations of hazardous materials at the facility. Businesses are required to update their business plans at least once every three years and the chemical portion of their plans every year. Also, business plans must include emergency response plans and procedures to be used in the event of a significant or threatened significant release of a hazardous material. These plans need to identify the procedures to follow for immediate notification to all appropriate agencies and personnel of a release, identification of local emergency medical assistance appropriate for potential accident scenarios, contact information for all company emergency coordinators, a listing and location of emergency equipment at the business, an evacuation plan, and a training program for business personnel. The requirements for hazardous materials business plans are specified in the California Health and Safety Code and 19 CCR.

Hazardous Materials Transportation in California: California regulates the transportation of hazardous waste originating or passing through the State in Title 13, CCR. The California Highway Patrol (CHP) and Caltrans have primary responsibility for enforcing federal and state regulations and responding to hazardous materials transportation emergencies. The CHP enforces materials and hazardous waste labeling and packing regulations that prevent leakage and spills of material in transit and provide detailed information to cleanup crews in the event of an incident. Vehicle and equipment inspection, shipment preparation, container identification, and shipping documentation are all part of the responsibility of the CHP. Caltrans has emergency chemical spill identification teams at locations throughout the State.

California Fire Code: While NFC Standard 45 and NFPA 704 are regarded as nationally recognized standards, the California Fire Code (24 CCR) also contains state standards for the use and storage of hazardous materials and special standards for buildings where hazardous materials are found. Some of these regulations consist of amendments to NFC Standard 45. State Fire Code regulations require emergency pre-fire plans to include training programs in first aid, the use of fire equipment, and methods of evacuation.

3.3.2.3 Local Regulations

Most counties in California have prepared Hazardous Waste Management Plans (HWMPs) that outlines how hazardous waste generated in the county is managed. The HWMP identifies the types and amounts of wastes generated; establishes programs for managing these wastes; identifies an application review process for the siting of specified hazardous waste facilities; identifies mechanisms for reducing the amount of waste generated; and identifies goals, policies, and actions for achieving effective hazardous waste management

Contra Costa County has adopted an industrial safety ordinance that addresses the human factors that lead to accidents. The ordinance requires stationary sources to develop a written human factors program that considers human factors as part of process hazards analyses, incident investigations, training, operating procedures, among others.

3.3.3 SIGNIFICANCE CRITERIA

The impacts associated with hazards will be considered significant if any of the following occur:

- Non-compliance with any applicable design code or regulation.
- Non-conformance to National Fire Protection Association standards.

- Non-conformance to regulations or generally accepted industry practices related to operating policy and procedures concerning the design, construction, security, leak detection, spill containment or fire protection.
- Exposure to hazardous chemicals in concentrations equal to or greater than the Emergency Response Planning Guideline (ERPG) 2 levels.

3.3.4 ENVIRONMENTAL IMPACTS

As discussed previously, the NOP/IS (see Appendix A) found that the Expedited BARCT Implementation Schedule would require facilities and refineries to install new or modify their existing air pollution control equipment. Under the Expedited BARCT Implementation Schedule, industrial facilities that participate in the GHG Cap-and-Trade system in the Bay Area would be required to implement BARCT to reduce their criteria pollutant emissions. Additional hazard and hazardous material impacts are expected to result from the operation of several of the possible control technologies that would most likely be used.

The Expedited BARCT Implementation Schedule is designed to reduce criteria pollutant emissions from industrial sources that currently participate in the GHG Cap-and-Trade system in the Bay Area. The proposed project is not expected to require substantial new development. Any new air pollution control equipment would be expected to occur within existing commercial or industrial facilities. Facility modifications associated with the proposed project are expected to include additional lime injection at cement plants, increased LDAR in heavy liquid service at refineries, thermal incinerators, vapor combustors, vapor recovery units, the installation of SCRs, wet gas scrubbers, electrostatic precipitators, and/or LoTOX™ injection. The hazards associated with the use of these types of air pollution control equipment is summarized in Table 3.3-4 and the impacts of those with potential hazard impacts are discussed further in the subsections below.

3.3.4.1 Additional Lime Injection

3.3.4.1.1 Lime

Lime: Lime is a calcium-containing inorganic material in which oxides and hydroxides predominate. Powder hydrate lime ($Ca(OH_2)$) is transported via truck to the existing cement kiln and stored in bins. Lime is mixed with water to create a slurry for use in the cement kiln for emission control. Lime is not regulated as a toxic air contaminant by OEHHA. The hazard ratings of hydrated lime are: Health is rated 3 (highly hazardous) because it can cause severe irritation or burning when it comes into contact with eyes, skin, through ingestion, or if the powder becomes airborne and is inhaled. A release would not generate a gas cloud that could migrate offsite and affect a large number of people because lime is solid at standard temperature and pressures. Rather the health hazards would be limited to the workers at the facility (cement kiln) and emergency repose individuals that may come into contact with a spill during release or clean-up activities. The use of lime would occur at an existing cement kiln than already uses, stores, and transports lime for emission control purposes and the additional use of lime is not expected to result in any new hazard impacts.

TABLE 3.3-4

Potential Hazards Impacts from Installing Air Pollution Control Equipment

Potential Control Technology	Hazards Impact	Analyzed Further?
Domes on Storage Tanks	None Identified	**No**
Vapor Recovery Unit	None identified	**No**
Thermal Incinerator	None identified	**No**
Vapor Combustor	None identified	**No**
Additional Lime Injection	Potential hazards associated with increased use of lime	**Yes**
Wet Gas Scrubbers	Potential hazards associated with increased use of caustic	**Yes**
Electrostatic Precipitator (Wet and Dry)	Potential for explosion	**Yes**
Increased LDAR	None Identified	**No**
SO_2 Reducing Catalyst	None Identified	**No**
LoTOX™	Potential hazards associated with increased use of caustic or lime	**No**
Selective Catalytic Reduction	Potential hazards associated with increased use of ammonia	**Yes**

3.3.4.1 Wet Gas Scrubber

3.3.4.1.1 Caustic

For any operators at potentially affected refineries who choose to install a WGS, hazardous materials may be needed to operate the WGSs depending on the source category. Caustic is a key ingredient needed for the operation of a WGS; it is the most widely used substance for several pollutant control applications spanning multiple equipment/source categories. While there are several types of caustic solutions that can be used in WGS operations, caustic made from sodium hydroxide (NaOH) is most commonly used for WGSs for FCCUs and coke calciners.

NAOH: NaOH, used as caustic in a WGS, is a toxic air contaminant; it is also a noncancerous but acutely hazardous substance. Located on the SDS for NaOH (50 percent by weight), the hazards ratings are as follows: health is rated 3 (highly hazardous) because of its corrosivity, flammability is rated 0 (none), and reactivity is rated 1 (slightly hazardous). NaOH is considered to be hazardous for health reasons when it comes into contact with the skin, eyes or is ingested. A release of NaOH at refineries would not generate a large gas cloud that would migrate offsite and affect a large number of people. Rather the health hazards would be limited to refinery workers and emergency response individuals that may come into contact with the spill during release or clean-up activities. Use of NaOH caustic in a WGS would occur in at refineries that already use and store NaOH caustic for other purposes and additional use of NaOH is not expected to result in any new significant impacts.

Based on the above information, additional use of caustic in a WGS would not cause or contribute to exceedances of any applicable hazards and hazardous materials significance thresholds.

3.3.4.2 Electrostatic Precipitator

Electrostatic precipitators have several advantages compared with other air pollution control devices, in part, because they are very efficient collectors, even for small particles. Further, because the collection forces act only on the particles, ESPs can treat large volumes of gas with low pressure drops. They can collect dry materials, fumes, or mists. Electrostatic precipitators can also operate over a wide range of temperatures and generally have low operating costs. There are two broad types of ESPs, dry and wet.

3.3.4.2.1 Dry ESPs

Dry ESPs remove dust from the collection electrodes by vibrating the electrodes through the use of rappers. Wire-plate dry ESPs are by far the most common design of an ESP and are used in a number of industries, including petroleum refining. Dry ESPs remove dust from the collection electrodes by vibrating the electrodes through the use of rappers. Common types of rappers are gravity impact hammers and electric vibrators. For a given ESP, the rapping intensity and frequency must be adjusted to optimize performance. Sonic energy is also used to assist dust removal in some dry ESPs. The main components of dry ESPs are an outside shell to house the unit, high voltage discharge electrodes, grounded collection electrodes, a high voltage source, a rapping system, and hoppers.

Hazards associated with dry ESPs include fire and explosion hazards that can occur at the inlet to ESPs when highly charged dust particles are transported by a gas carrier that can contain the mixtures of both incombustible and combustible flue gases. The risk of ignition and even explosion is especially high in the presence of an explosive mixture of oxygen, hydrocarbons, carbon monoxide, etc. The ignition source is typically caused by the breakdown between the corona electrode and the collecting electrode, but in some cases electrostatic discharge (typically back corona) can also act as an ignition source.

Other problems that may contribute to fire or explosion hazards include the following: minimum clearance between electrodes may result in repeated “sparkover” causing local heating and vaporization of wires causing the wires to break; broken wires may swing freely and cause shorting between discharge and collector electrodes; excessive rapping may also break wires; poor electrical alignment may cause the wire frame to oscillate fatiguing wires and increasing sparking; if high levels of carbon are known to exist on the collecting surface or in the hoppers, opening the precipitator access doors may result in spontaneous combustion of the hot dust caused by the inrush of air.

Electrostatic Precipitators or ESPs have been used in industry for over 60 years. Although potential safety hazards exist for explosion or fire hazards associated with dry ESPs, standard industry practices and vendor safety recommendations, including frequent inspection and maintenance, air filter cleaning, use of hydrocarbon sensors, and electronic controls for process automation, are anticipated to reduce risks from operation of dry ESPs. Therefore, hazards and hazardous materials impacts from dry ESPs are concluded to be less than significant. Therefore, mitigation measures are not required.

3.3.4.2.2 Wet ESPs

The basic components of a wet ESP are the same as those of a dry ESP with the exception that a wet ESP requires a water spray system rather than a system of rappers. The gas stream is either saturated before entering the collection area or the collecting surface is continually wetted to prevent agglomerations from forming. Because the dust is removed from a wet ESP in the form of a slurry, hoppers are typically replaced with a drainage system. Wet ESPs have the following advantages over dry ESPs. Wet ESPs can adsorb gases, cause some pollutants to condense, are easily integrated with scrubbers, and eliminate re-entrainment of captured particles.

Particulates collected from wet ESPs are washed from the collection electrodes with water or another suitable liquid. Some wet ESP applications require that liquid is sprayed continuously into the gas stream; in other cases, the liquid may be sprayed intermittently. Since the liquid spray saturates the gas stream in a wet ESP, it also provides gas cooling and conditioning. Because particulates are removed from a wet ESP as a slurry, explosion hazards are unlikely (Dorman, 1974). Therefore, hazards and hazardous materials impacts from wet ESPs are concluded to be less than significant. Therefore, mitigation measures are not required.

3.3.4.3 Ammonia Use in SCRs

Expedited BARCT may require or encourage the use of SCR to reduce NOx emissions at Petroleum Coke Calcining facilities. Ammonia or urea is used to react with the NOx, in the presence of a catalyst, to form nitrogen gas and water. In some SCR installations, anhydrous ammonia is used. Although ammonia is currently used in SCRs throughout the Bay Area, safety hazards related to the transport, storage, and handling of ammonia exist. Ammonia has acute and chronic non-cancer health effects and also contributes to ambient PM_{10} emissions under some circumstances.

Onsite Release Scenario: The use of anhydrous ammonia involves greater risk than aqueous ammonia because it is stored and transported under pressure. In the event of a leak or rupture of a tank, anhydrous ammonia is released and vaporizes into the gaseous form, which is its normal state at atmospheric pressure and produces a toxic cloud. Aqueous ammonia is a liquid at ambient temperatures and gas is only produced when a liquid pool from a spill evaporates. Under current OES regulations implementing the CalARP requirements, both anhydrous and aqueous ammonia are regulated under California Health and Safety Code Section 2770.1.

Installing SCRs for refinery coke calciners could lead to increased use and storage of ammonia. One coke calciner is operated by Phillips 66 in the District, located in an industrial area of the City of Rodeo. However, the use and storage of anhydrous ammonia would be expected to result in significant hazard impacts as there is the potential for anhydrous ammonia to migrate off-site and expose individuals to concentrations of ammonia that could lead to adverse health impacts. Anhydrous ammonia would be expected to form a vapor cloud (since anhydrous ammonia is a gas at standard temperature and pressure) and migrate from the point of release. The number of people exposed and the distance that the cloud would travel would depend on the meteorological conditions present. Depending on the location of the spill, a number of individuals could be exposed to concentrations of ammonia that would exceed the ERPG2 concentrations. Residential areas are located within about 2,000 feet of the Phillips 66 coke calciner

In the event of an aqueous ammonia release, the ammonia solution would have to pool and spread out over a flat surface in order to create sufficient evaporation to produce a significant vapor cloud. For a release from onsite vessels or storage tanks, spills would be released into a containment area, which would limit the surface area of the spill and the subsequent toxic emissions. The containment area would limit the potential pool size, minimizing the amount of spilled material that would evaporate, form a vapor cloud, and impact residences or other sensitive receptors in the area of the spill. Significant hazard impacts associated with a release of aqueous ammonia would not be expected. Therefore, the use of aqueous ammonia is expected to be preferred over anhydrous ammonia.

Transportation Release Scenario: Use and transport of anhydrous ammonia involves greater risk than aqueous ammonia because it is stored and transported under pressure. In the event of a leak or rupture of a tank, anhydrous ammonia is released and vaporizes into the gaseous form, which is its normal state at atmospheric temperature and pressure, and produces a toxic cloud. Aqueous ammonia is a liquid at ambient temperatures and pressure, and gas is only produced when a liquid pool from a spill evaporates. Deliveries of ammonia would be made to each facility by tanker truck via public roads. The maximum capacity of a tanker truck is 150 barrels. Regulations for the transport of hazardous materials by public highway are described in 49 Code of Federal Regulations (CFR) 173 and 177. Nineteen percent aqueous ammonia is considered a hazardous material under 49 CFR 172.

Although trucking of ammonia and other hazardous materials is regulated for safety by the U.S. Department of Transportation, there is a possibility that a tanker truck could be involved in an accident spilling its contents. The factors that enter into accident statistics include distance traveled and type of vehicle or transportation system. Factors affecting automobiles and truck transportation accidents include the type of roadway, presence of road hazards, vehicle type, maintenance and physical condition, and driver training. A common reference frequently used in measuring risk of an accident is the number of accidents per million miles traveled. Complicating the assessment of risk is the fact that some accidents can cause significant damage without injury or fatality.

The actual occurrence of an accidental release of a hazardous material cannot be predicted. The location of an accident or whether sensitive populations would be present in the immediate vicinity also cannot be identified. In general, the shortest and most direct route that takes the least amount of time would have the least risk of an accident. Hazardous material transporters do not routinely avoid populated areas along their routes, although they generally use approved truck routes that take population densities and sensitive populations into account.

The hazards associated with the transport of regulated (CCR Title 19, Division 2, Chapter 4.5 or the CalARP requirements) hazardous materials, including ammonia, would include the potential exposure of numerous individuals in the event of an accident that would lead to a spill. Factors such as amount transported, wind speed, ambient temperatures, route traveled, and distance to sensitive receptors are considered when determining the consequence of a hazardous material spill.

In the unlikely event that the tanker truck would rupture and release the entire 150 barrels of aqueous ammonia, the ammonia solution would have to pool and spread out over a flat surface in order to create sufficient evaporation to produce a significant vapor cloud. For a road accident, the roads are usually graded and channeled to prevent water accumulation and a spill would be channeled to a low spot or drainage system, which would limit the surface area of the spill and the subsequent toxic emissions. Additionally, the roadside surfaces may not be paved and may absorb some of the spill. Without this pooling effect on an impervious surface, the spilled ammonia would not evaporate into a toxic cloud and impact residences or other sensitive receptors in the area of the spill. An accidental aqueous ammonia spill occurring during transport is, therefore, not expected to have significant impacts.

In the unlikely event that a tanker truck would rupture and release the entire contents of anhydrous ammonia, the ammonia would be expected to form a vapor cloud (since anhydrous ammonia is a gas at standard temperature and pressure) and migrate from the point of release. There are federal, State and local agencies with jurisdiction over hazardous materials and waste that are responsible for ensuring that hazardous materials and waste handling activities are conducted in accordance with applicable laws and regulations. While compliance with these laws and regulations will minimize the chance of an accidental release of anhydrous ammonia, the potential will still exist that an unplanned release could occur. The number of people exposed and the distance that the cloud would travel would depend on the meteorological conditions present. Depending on the location of the spill, a number of individuals could be exposed to high concentrations of ammonia resulting in potentially significant impacts.

3.3.4.4 Releases During Transport

3.3.4.4.1 Lime

It is conservatively estimated that the cement kiln would double the amount of lime that it uses and import an additional 5,800 tons of hydrated lime per year. Each truck holds about 20 tons of lime for an estimated increase of 290 trucks per year, or an estimated one truck per day. Operators of trucks that transport hazardous materials by public highway are required to comply with requirements described in 49 CFR §§ 173 and 177 which establishes numerous requirements for the transport of hazardous materials, from the training and requirements of drivers, to the specifications and requirements of the trucks used to transport the material. Significant adverse hazards and hazardous materials impacts during use or transport of lime to a facility or transport are expected to be less than significant because of they do not pose adverse health or physical hazard impacts and, in the event of an accidental release, the lime would be easily contained (because it is a solid at standard temperature and pressures) and cleaned up. Based on the above information, accidental releases of lime during transport would not cause or contribute to exceedances of any applicable hazards and hazardous materials significance thresholds.

3.3.4.4.2 Oxidation Catalyst

A typical oxidation catalyst system is not expected to require more than several hundred pounds of catalyst modules per year. As a result, delivery of catalyst modules can be accomplished in one truck trip. Based on their chemical and physical properties (solid material), oxidation catalysts are not expected to pose significant adverse health or physical hazard impacts during use. Similarly, significant adverse hazards and hazardous materials impacts during use or transport of new catalysts to a facility or transport of spent catalysts for recycling are expected to be less than significant because of they do not pose adverse health or physical hazard impacts and, in the event of an accidental release, the modules would be easily contained and cleaned up.

3.3.4.4.3 Wet Gas Scrubber

Installation of a WGS would require deliveries of fresh caustic. If an accidental release of caustic during transport occurs, potentially significant adverse hazards or hazardous materials impacts may be generated.

NaOH: Deliveries of NaOH (50 percent by weight) are typically made by tanker truck via public roads. The maximum capacity of one NaOH tanker truck is approximately 6,000 gallons. The projected consumption rates of NaOH are assumed to range from approximately 160 tons per year (T/Y) (0.44 tons per day (T/D)) to 1,228 T/Y (3.37 T/D) based on an analysis of WGS for refineries in southern California (SCAQMD, 2008). Based on worst-case assumptions, an affected refinery would need up to an additional 32 truck trips of NaOH caustic per year[1]. Although some of the affected refineries currently receive NaOH caustic, it is likely that they receive shipments periodically throughout the year rather than on a daily basis. Therefore, it is unlikely that an affected refinery would require one delivery per day in addition to any existing deliveries of NaOH caustic, instead it is likely that NaOH deliveries would occur on more days per year. Operators of trucks that transport hazardous materials by public highway are required to comply with requirements described in 49 CFR §§ 173 and 177. Hazardous materials impacts during the transport of NaOH caustic are considered to be less than significant.

Based on the above information, accidental releases of caustic during transport would not cause or contribute to exceedances of any applicable hazards and hazardous materials significance thresholds.

[1] Annual NaOH deliveries are calculated based on one delivery truck holding 6,000 gallons per truck load. For example, 1,228 T/Y NaOH x 2,000 lbs/ ton = 2,465.000 lbs/yr x 1 gal NaOH @ 50%/12.77 lbs = 192,000 gal/year x 1 truck/6,000 gallons = 32 trucks/year

3.3.5 MITIGATION MEASURES

Hazards and hazardous materials impacts are expected to be less than significant; therefore, no mitigation measures are required.

3.3.6 CUMULATIVE IMPACTS

As concluded in the above hazards and hazardous materials analysis, installation of air pollution control equipment, if required in the future, is not expected to cause or contribute to significant adverse hazard or hazardous materials impacts. Therefore, overall hazards and hazardous materials impacts, including accidental releases of hazardous materials during transport, were concluded to be less than significant. Because hazards and hazardous materials impacts do not exceed the applicable hazards and hazardous materials significance thresholds, they are not considered to be cumulatively considerable (CEQA Guidelines §15064 (h)(1)) and, therefore are not expected to generate significant adverse cumulative hazards and hazardous materials impacts.

CHAPTER 3.4

HYDROLOGY AND WATER QUALITY

Introduction
Environmental Setting
Regulatory Setting
Significance Criteria
Hydrology and Water Quality Impacts
Mitigation Measures
Cumulative Impacts

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3.4 HYDROLOGY AND WATER QUALITY

This subchapter of the EIR evaluates the potential hazards and hazardous material impacts associated with the Expedited BARCT Implementation Schedule, which aims to reduce criteria pollutant emissions from industrial sources that currently participate in the GHG Cap-and-Trade system.

As discussed in the Initial Study, in accordance with AB 617, the purpose of the Expedited BARCT Implementation Schedule is to implement several rule development projects that utilize BARCT to reduce criteria pollutant emissions from industrial sources participating in the GHG Cap-and-Trade system throughout the Bay Area. The NOP/IS concluded that certain control equipment, particularly wet gas scrubbers, could result in a substantial increase in water use or wastewater discharge.

The NOP/IS determined that the potential flooding, flood hazards and increased stormwater runoff impacts were less than significant as modifications would occur at existing facilities that have been graded and developed. Therefore, project-specific and cumulative adverse water demand and water quality impacts associated with the Expedited BARCT Implementation Schedule have been evaluated in Chapter 3.4 of this EIR. It should be noted that the NOP/IS concluded that the potential utilities and service system impacts were potentially significant due to an increase in water demand. The EIR consolidated the potential water demand impacts on both hydrology and water quality and utilities and service systems in this Subchapter 3.4

3.4.1 ENVIRONMENTAL SETTING

3.4.1.1 Regional Hydrology

The state of California is divided into ten hydrologic regions corresponding to the state‘s major water drainage basins. The hydrologic regions define a river basin drainage area and are used as planning boundaries, which allows consistent tracking of water runoff, and the accounting of surface water and groundwater supplies. The Air District is within the San Francisco Bay Hydrologic Region (Bay Region) which includes all of San Francisco County and portions of Marin, Sonoma, Napa, Solano, San Mateo, Santa Clara, Contra Costa, and Alameda counties. It occupies approximately 4,500 square miles; from southern Santa Clara County to Tomales Bay in Marin County; and inland to near the confluence of the Sacramento and San Joaquin rivers at the eastern end of Suisun Bay. The eastern boundary follows the crest of the Coast Ranges, where the highest peaks are more than 4,000 feet above mean sea level (CDWR, 2013).

The San Francisco Bay estuary system is one of the largest in the country and drains approximately 40 percent of the state’s surface water from the Sierra Nevada and the Central Valley. The two major drainages, the Sacramento and San Joaquin Rivers, receive more than 90 percent of runoff during the winter and spring months from rainstorms and snow melt. Water from these drainages flows into what is known as the Delta region, then into the sub-bays, Suisun Bay and San Pablo Bay, and finally into the Central Bay and out the Golden Gate. Nearly half of the surface water in California starts as rain or snow that falls within the watershed and flows downstream toward the Bay. Much of the water flowing toward the Bay is diverted for agricultural, residential, and industrial purposes as well as delivery to distant cities of southern California as part of state and federal water projects (ABAG, 2017).

The two major drainages, the Sacramento and San Joaquin Rivers receive more than 90 percent of runoff during the winter and spring months from rainstorms and snow melt. Other surface waters flow either directly to the Bay or Pacific Ocean. The drainage basin that contributes surface water flows directly to the Bay covers a total area of 3,464 square miles. The largest watersheds include Alameda Creek (695 square miles), the Napa River (417 square miles), and Coyote Creek (353 square miles) watersheds. The San Francisco Bay estuary includes deep-water channels, tidelands, and marshlands that provide a variety of habitats for plants and animals. The salinity of the water varies widely as the landward flows of saline water and the seaward flows of fresh water converge near the Benicia Bridge. The salinity levels in the Central Bay can vary from near oceanic levels to one quarter as much, depending on the volume of freshwater runoff (ABAG 2017).

3.4.1.2 Surface Water Hydrology

Surface waters in the Bay Area include freshwater rivers and streams, coastal waters, and estuarine waters. Many of the original drainages toward the San Francisco Bay have been channelized and put underground through urbanization of the areas. Estuarine waters include the San Francisco Bay Delta from the Golden Gate Bridge to the Sacramento and San Joaquin Rivers, and the lower reaches of various streams that flow directly into the Bay, such as the Napa and Petaluma Rivers in the North Bay, and the Coyote and San Francisquito Creeks in the South Bay. Major water bodies, including creeks and rivers, in the Bay Area are summarized in Table 3.4-1.

The most prominent surface water body in the Bay Region is San Francisco Bay itself. Other surface water bodies include: creeks and rivers; ocean bays and lagoons (such as Bolinas Bay and Lagoon, Half Moon Bay, and Tomales Bay); urban lakes (such as Lake Merced and Lake Merritt); and human-made lakes and reservoirs (such as Lafayette Reservoir, Briones Reservoir, Calaveras Reservoir, Crystal Springs Reservoir, Kent Lake, Lake Chabot, Lake Hennessey, Nicasio Reservoir, San Andreas Lake, San Antonio Reservoir, San Pablo Reservoir, Upper San Leandro Reservoir, Anderson Reservoir, and Lake Del Valle).

TABLE 3.4-1

Watersheds of the San Francisco Bay Hydrologic Region

LOCATION	WATERSHED
North Bay	Corte Madera Creek Watershed
	Novato Creek Watershed
	Petaluma River Watershed
	Sonoma Creek Watershed
	Napa River Watershed
	Marin and North Bay Coastal Drainages(1)
Suisun Bay	GreenValley/Suisun Creeks watersheds
	Walnut Creek Watershed
	San Pablo/Wildcat Creeks Watersheds
	Suisun Bay Drainages(2)
East Bay	San Leandro Creek Watershed
	San Lorenzo Creek Watershed
	Alameda Creek Watershed
	East Bay Drainages(3)
South Bay	Coyote Creek Watershed
	Guadalupe River Watershed
	West Santa Clara Valley Drainages(4)
Peninsula	San Francisquito Creek Watershed
	San Mateo Creek Watershed
	San Mateo and Peninsula Coastal Drainages(5)

Source: ABAG, 2017

(1) Including Lagunitas Creek, Arroyo Corte Madera Creek, Miller Creek, etc.
(2) Including Sulphur Springs Creek, Laurel Creek, Mt. Diablo Creek, etc.
(3) Including Rodeo Creek, Cordonices Creek, Claremont Creek, Peralta Creek, Lake Merritt, etc.
(4) Including Stevens Creek, Permanente Creek, Saratoga Creek, etc.
(5) Including Cordilleras Creek, Colma Creek, Pilarcitos Creek, Pescadero Creek, San Gregorio Creek, etc.

3.4.1.3 Groundwater

A groundwater basin is an area underlain by permeable materials capable of storing a significant amount of water. Groundwater basins are closely linked to local surface waters. As water flows from the hills toward the Bay, it percolates through permeable soils into the groundwater basins. The nine-county Bay Area contains a total of 28 groundwater basins. The ten primary groundwater basins are the Petaluma Valley, Napa-Sonoma Valley, Suisun-Fairfield Valley, San Joaquin Valley, Clayton Valley, Diablo Valley, San Ramon Valley, Livermore Valley, Sunol Valley, and Santa Clara Valley basins. Groundwater in the Bay Area is used for numerous purposes, including municipal and industrial water supply; however, groundwater use accounts for only about five percent of the total water usage (ABAG, 2017).

3.4.1.4 Water Quality

The quality of regional surface water resources in the Bay Area varies considerably and is locally affected by point-source and nonpoint-source discharges throughout individual watersheds.

Regulated point sources, such as wastewater treatment effluent and industrial waste water discharges, usually involve a single point discharge into receiving waters. Point-source pollutants can also enter water bodies from urban runoff that includes oil and gasoline by-products from parking lots, streets, and freeways that are collected in drainage systems and discharged directly to surface waters. Most urban runoff flows untreated into creeks, lakes, and San Francisco Bay. This nonpoint-source runoff often carries pollutants that contribute heavy metals (and other pollutants) to local waters. Other pollutant sources include upstream historic and current mining discharges and legacy pollutants that were historically emitted by industry or other human activities, but are currently banned or significantly restricted from current usage. Examples include mercury, lead, polychlorinated biphenyls, and dichlorodiphenyltrichloroethane (ABAG, 2017).

Nonpoint-source pollutants are transported into surface waters through rainfall, air, and other pathways. The nonpoint-source pollutants originate from many diffuse sources and are the leading cause of water quality degradation in the region's waterways. Regionally, stormwater runoff is estimated to contribute more heavy metals to San Francisco Bay than direct municipal and industrial dischargers, as well as significant amounts of motor oil, paints, chemicals, debris, grease, and detergents. Runoff in storm drains may also include pesticides and herbicides from landscaping products and bacteria from animal waste (ABAG, 2017).

In addition to the degradation of water quality in many of the region's surface waters, many of the region's creeks are channelized, culverted, or otherwise altered, which has had adverse effects on aquatic and riparian habitats, sediment transfer, and hydrology. Water quality in the more rural areas of the region has also been affected by grazing and agriculture, confined animal facilities, onsite sewage systems, and land conversions. Coastal watersheds have been impaired because of sedimentation and habitat degradation (ABAG, 2017).

The San Francisco Bay Regional Water Quality Control Board (RWQCB), the main agency charged with protecting and enhancing surface water and groundwater quality in the Bay Area, has classified the San Francisco Bay and man of its tributaries as impaired for various water quality constituents, as required by the Clean Water Act (CWA). The San Francisco RWQCB implements the Total Maximum Daily Load (TMDL) Program for impaired water bodies, which involves determining a safe level of loading for each problem pollutant, determining the pollutant sources, allocating loads to all of the sources, and implementing the load allocations. The list of impaired water bodies includes more than 270 listings in 88 water bodies. RWQCB staff are currently developing TMDL projects or studies to address more than 160 of these listing. SFBRWQCB is taking a watershed management approach to runoff source issues, including TMDL implementation, by engaging all affected stakeholders in designing and implementing goals on a watershed basis to protect water quality. Completed and current TMDL projects in the Bay Area are listed in Table 3.4-2.

TABLE 3.4-2

TMDL Projects in the Bay Area

WATER BODY	POLLUTANT
Guadalupe River Watershed	Mercury
Lagunitas Creek	Sediment
Napa River	Sediment and Pathogens
North San Francisco Bay	Selenium
San Francisco Bay Beaches	Bacteria
San Francisco Bay	Mercury and PCBs
San Vicente Creek and Fitzgerald Marine Reserve	
San Pedro Creek and Pacifica State Beach	Bacteria
Sonoma Creek	Pathogens and Sediment
Tomales Bay	Mercury and Pathogens
Urban Creeks	Pesticide Toxicity
Walker Creek	Mercury
Butano and Pescadero Creeks	Sediment
Permanente Creek	Selenium
San Francisquito Creek	Sediment
Stevens Creek	Toxicity
Suisun Marsh	Low Dissolved Oxygen, Organic Enrichment, Mercury, Nutrients, and Salinity

Source: ABAG, 2017

3.4.1.5 Water Supply and Demand

Water supply for each county is provided by its respective water supply department or agency. The following water agencies serve the majority of the water demands in the Bay Area Region:

- Alameda County Water District (ACWD)
- Contra Costa Water District (CCWD)
- East Bay Municipal Utility District (EBMUD)
- Marin Municipal Water District (MMWD)
- City of Napa Water Department
- San Francisco Public Utilities Commission (SFPUC)
- Santa Clara Valley Water District (SCVWD)
- Solano County Water Agency (Solano CWA)
- Sonoma County Water Agency (Sonoma CW)
- Zone 7 Water Agency (Zone 7)

The Bay Area relies on imported water, local surface water, and groundwater for water supply. Local supplies account for about 31 percent of the total, and the remaining supply is imported from the State Water Project (SWP) (13 percent), Central Valley Project (CVP) (15 percent), the Mokelumne watershed (19 percent), and the Tuolumne watersheds (19 percent). Table 3.4-3 shows the projected water supplies and demands from recent urban water management plans (UWMP) for normal years in the future (2020) and over the next twenty years. All of the water districts will be able to provide adequate water supplies to meet projected demand in a year of normal precipitation, although doing so requires some districts to acquire additional supplies (ABAG, 2017).

TABLE 3.4-3

Projected Normal Year Water Supply and Demand (acre-feet per year)

Water Agency	2020 Water Supply	2020 Demand	Future Water Supply (2040)	Future Water Demand (2040)
Alameda County WD	78,000	63,400	78,000	70,300
Contra Costa WC	329,200	264,000	362,800	303,900
East Bay Municipal Utility District	243,000	243,000	258,000	258,000
Marin Municipal WD	151,000	42,000	153,000	42,000
City of Napa	52,000	14,000	52,000	15,000
San Francisco PUC	87,000	87,000	101,000	101,000
Santa Clara Valley WD	390,000	376,000	442,000	435,000
Solano County WA(1)	255,000	255,000	255,000	255,000
Sonoma County WA	66,000	66,000	76,000	76,000
Zone 7 WA	79,000	72,000	100,000	93,000

Source: ABAG, 2017
(1) Future supply and demand are for the year 2030.

Some Bay Area water agencies are projecting future water supply shortfalls in dry years (including Alameda County Water District -2020, Santa Clara Valley Water District – 2040, and Sonoma County Water Agency – 2025), and some are already seeing such shortfalls (including East Bay Municipal Utility District, City of Napa Water Department, and Solano County Water Agency). Other agencies anticipate being able to handle a single dry year, largely because of reservoirs, or other storage capacity, including Contra Costa Water District, Marin Municipal Water District, San Francisco Public Utilities Commission, and Zone 7 Water Agency. The severity and timing of dry year shortfalls differ greatly among the agencies because of the wide variation of supply sources, types of use, and climates within the region. Shortages in precipitation in the Sierra Nevada can have a pronounced effect on water supply in the region than a drought in the Bay Area itself because of the reliance of the region on water from the Tuolumne and Modelumne watersheds (ABAG, 2017).

3.4.1.6 Drinking Water Quality

Drinking water in the Bay Region ranges from high-quality Mokelumne and Tuolumne River water to variable-quality Delta water, which constitutes about one-third of the domestic water supply. Purveyors that depend on the Delta for all or part of their domestic water supply can meet drinking water standards, but still need to be concerned about microbial contamination, salinity, and organic carbon.

In 2013, the SWRCB completed a statewide report titled, "Communities that Rely on a Contaminated Groundwater Source for Drinking Water." The report identified contaminated wells statewide that exceed a primary drinking water standard prior to any treatment or blending. In the Bay Region, 28 contaminated wells were identified that are used by 18 water systems. Most of the affected drinking water systems are small and often need financial assistance to construct a water treatment plant or another facility to meet drinking water standards. The most prevalent contaminants in the region are arsenic, nitrate, and aluminum (CDWR, 2013).

3.4.1.7 Recycled Water

In the 1990s, a number of local agencies joined with the CDWR and the United States Bureau of Water Reclamation to study the feasibility of using high-quality recycled water to augment water supplies and help the Bay-Delta ecosystem. This cooperative effort, known as the Bay Area Regional Water Recycling Program (BARWRP), produced a Master Plan for regional water recycling in 1999 for the five South Bay counties. Since then, local water agencies have built a number of projects consistent with BARWRP, and recycled water has come to be widely used in the Bay Area for a number of applications, including landscape irrigation, agricultural needs, commercial and industrial purposes, and as a supply to the area's wetlands. In 2010, the Bay Area recycled approximately 60,000 acre-feet of water per year, almost 10 percent of the wastewater effluent generated, and supply is expected to more than double over the next 20 years (ABAG, 2017). The largest use of recycled water is for landscape irrigation, including golf courses, wetlands, industrial uses, and agricultural irrigation.

3.4.1.8 Desalination

The Alameda County Water District opened the Newark Desalination Facility in 2003, and has a capacity of 12.5 million gallons per day. The five largest water agencies in the Bay Area (SCCWD, EBMUC, SFPUC, SCVWD, and Zone 7) are currently studying the feasibility of constructing a 10 to 20 million gallon per day desalination facility in eastern Contra Costa County (ABAG, 2017).

3.4.1.9 Wastewater Treatment

Wastewater is generated by residential, commercial and industrial sources throughout the Bay Area. The Clean Water Act requires treatment of wastewater for the protection of human health and receiving water bodies and preservation of the health of aquatic and riparian species. Wastewater treatment facilities consist of staged processes with the specific treatment systems authorized through NPDES permits. Primary treatment generally consists of initial screening and clarifying. Primary clarifiers are large pools where solids in wastewater are allowed to settle out. The clarified water is pumped into secondary clarifiers and the screenings and solids are collected, processed through large digesters to break down organic contents, dried and pressed, and either disposed of in landfills or used for beneficial agricultural applications. Secondary clarifiers repeat the process of the primary clarifiers further, refining the effluent.

Other means of secondary treatment include flocculation (adding chemicals to precipitate solids removal) and aeration (adding oxygen to accelerate breakdown of dissolved constituents). Tertiary treatment involves the removal of nutrients and nearly all suspended organic matter from wastewater, and may consist of filtration, disinfection, and reverse osmosis technologies. Chemicals are added to the wastewater during the primary and secondary treatment processes to accelerate the removal of solids and to reduce odors. Chlorine is often added to eliminate pathogens during final treatment, and sulfur dioxide is often added to remove the residual chlorine. Methane produced by the treatment processes can be used as fuel for the plant's engines and electricity needs. Recycled water must receive a minimum of tertiary treatment in compliance with DHS regulations. Water used to recharge potable groundwater supplies generally receives reverse osmosis and microfiltration prior to reuse (Water Education Foundation, 2013).

Wastewater treatment in the Bay Area is provided by various agencies as well as individual city and town wastewater treatments. Treated wastewater is generally discharged into a water body, evaporation pond or percolation basin, or used recycled for agriculture, irrigation or landscaping. The U.S. EPA's NPDES permit program affects how a municipality handles its sanitary wastewater. Tertiary treatment is now commonly required for discharges to bodies of water, particularly where there is potential for human contact. Properly managed wastewater treatment systems play an important role in protecting community health and local water quality

3.4.2 REGULATORY SETTING

There are a variety of overlapping federal, state and local regulations that regulate water resources and water quality. A number of federal regulations (e.g., the Clean Water Act) are primarily implemented by state agencies with oversight from the U.S. EPA. This section summarizes the more pertinent federal, state and local regulations on water resources.

3.4.2.1 Federal Regulations

3.4.2.1.1 Clean Water Act

The Clean Water Act (CWA) establishes the basic structure for regulating discharges of pollutants into "waters of the United States." The Act specifies a variety of regulatory and non-regulatory tools to sharply reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. Some of these tools include:

- Section 303(d) – Total Maximum Daily Loads (TMDLs);
- Section 401 – Water Quality Certification;
- Section 402 – National Pollutant Discharge Elimination System (NPDES) Program; and
- Section 404 – Discharge of Dredge or Fill Material.

Section 303(d) – Total Maximum Daily Loads (TMDLs): The CWA §303(d) requires the SWRCB to prepare a list of impaired water bodies in the state and determine total maximum daily loads (TMDLs) for pollutants or other stressors impacting water quality of these impaired water bodies. A TMDL is a quantitative assessment of water quality conditions, contributing sources, and the load reductions or control actions needed to restore and protect bodies of water in order to meet their beneficial uses. All sources of the pollutants that caused each body of water to be included on the list, including point sources and non-point sources, must be identified. The California §303 (d) list was completed in March 1999. On July 25, 2003, U.S. EPA gave final approval to California's 2002 revision of §303 (d) List of Water Quality Limited Segments. A priority schedule has been developed to determine TMDLs for impaired waterways. TMDL projects are in various stages throughout the District for most of the identified impaired water bodies. The Regional Water Quality Control Boards are responsible for ensuring that total discharges do not exceed TMDLs for individual water bodies as well as for entire watersheds.

Section 401 – Water Quality Certification: The RWQCBs coordinate the State Water Quality Certification program, or CWA §401. Under CWA §401, states have the authority to review any federal permit or license that will result in a discharge or disruption to wetlands and other waters under state jurisdiction to ensure that the actions will be consistent with the state‘s water quality requirements. This program is most often associated with CWA §404 which obligates the U.S. Army Corps of Engineers to issue permits for the movement of dredge and fill material into and from “waters of the United States”.

Section 402 – National Pollutant Discharge Elimination System (NPDES) Program: Section 402 regulates point-source discharges to surface waters through the National Pollutant Discharge Elimination System (NPDES) program. In California, the SWRCB oversees the NPDES program, which is administered by the RWQCBs. The NPDES program provides for both general permits (those that cover a number of similar or related activities) and individual permits. The NPDES program covers municipalities, industrial activities, and construction activities. The NPDES program includes an industrial stormwater permitting component that covers ten categories of industrial activity that require authorization under an NPDES industrial stormwater permit for stormwater discharges. The NPDES permit establishes discharge pollutant thresholds and operational conditions for industrial facilities and wastewater treatment plants. For point source discharges (e.g., wastewater treatment facilities), the RWQCBs prepare specific effluent limitations for constituents of concern such as toxic substances, total suspended solids (TSS), bio-chemical oxygen demand (BOD), and organic compounds.

Construction activities, also administered by the State Water Board, are discussed below under state regulations. Section 402(p) of the federal Clean Water Act, as amended by the Water Quality Act of 1987, requires NPDES permits for stormwater discharges from municipal separate storm sewer systems (MS4s), stormwater discharges associated with industrial activity (including construction activities), and designated stormwater discharges, which are considered significant contributors of pollutants to waters of the United States. On November 16, 1990, U.S. EPA published regulations (40 CFR Part 122), which prescribe permit application requirements for MS4s pursuant to CWA 402(p). On May 17, 1996, U.S. EPA published an Interpretive Policy Memorandum on Reapplication Requirements for Municipal Separate Storm Sewer Systems, which provided guidance on permit application requirements for regulated MS4s. MS4 permits include requirements for post-construction control of stormwater runoff in what is known as Provision C.3. The goal of Provision C.3 is for the Permittees to use their planning authorities to include appropriate source control, site design, and stormwater treatment measures in new development and redevelopment projects to address both soluble and insoluble stormwater runoff pollutant discharges and prevent increases in runoff flows from new development and redevelopment projects. This goal is to be accomplished primarily through the implementation of low impact development (LID) techniques.

3.4.2.1.2 Safe Water Drinking Act (SDWA)

Passed in 1974 and amended in 1986 and 1996, the SDWA gives the U.S. EPA the authority to set drinking water standards. Drinking water standards apply to public water systems, which provide water for human consumption through at least 15 service connections, or regularly serve at least 25 individuals. There are two categories of drinking water standards, the National Primary Drinking Water Regulations (NPDWR) and the National Secondary Drinking Water Regulations (NSDWR). The NPDWR are legally enforceable standards that apply to public water systems. NPDWR standards protect drinking water quality by limiting the levels of specific contaminants that can adversely affect public health and are known or anticipated to occur in water.

3.4.2.1.3 Section 10 of the Rivers and Harbors Act

Section 10 of the Rivers and Harbors Act, administered by United States Army Corp of Engineers (U.S. ACE), requires permits for all structures (such as riprap) and activities (such as dredging) in navigable waters of the U.S.

3.4.2.1.4 Executive Order 11990 – Protection of Wetlands

Executive Order 11990 is an overall wetlands policy for all agencies managing federal lands, sponsoring federal projects, or providing federal funds to state or local projects. Executive Order 11990 requires that when a construction project involves wetlands, a finding must be made by the federal agency that there is no practicable alternative to such construction, and that the proposed action includes all practicable measures to minimize impacts to wetlands resulting from such use.

3.4.2.2 State Regulations

3.4.2.2.1 Porter-Cologne Water Quality Control Act

The Porter-Cologne Water Quality Control Act established the SWRCB and divided the state into nine regions, each overseen by a RWQCB. The nine regional boards have the primary responsibility for the coordination and control of water quality within their respective jurisdictional boundaries. Under the Porter-Cologne Water Quality Control Act, water quality objectives are limits or levels of water quality constituents or characteristics established for the purpose of protecting beneficial uses. The Act requires the RWQCBs to establish water quality objectives while acknowledging that water quality may be changed to some degree without unreasonably affecting beneficial uses. Designated beneficial uses, together with the corresponding water quality objectives, also constitute water quality standards under the federal Clean Water Act. Therefore, the water quality objectives form the regulatory references for meeting state and federal requirements for water quality control.

Each RWQCB is required to prepare and update a Basin Plan for their jurisdictional area. Pursuant to the CWA NPDES program, the RWQCB also issues permits for point source discharges that must meet the water quality objectives and must protect the beneficial uses defined in the Basin Plan.

3.4.2.2.2 Construction General Permit

The California Construction Stormwater Permit (Construction General Permit), adopted by the State Water Resources Control Board, regulates construction activities that include clearing, grading, and excavation resulting in soil disturbance of at least one acre of total land area. Individual storm water NPDES permits are required for specific industrial activities and for construction sites greater than five acres. Statewide general storm water NPDES permits have been developed to expedite discharge applications. They include the statewide industrial permit and the statewide construction permit. A prospective applicant may apply for coverage under one of these permits and receive Waste Discharge Requirements (WDRs) from the appropriate RWQCB. WDRs establish the permit conditions for individual dischargers. The Stormwater Rule automatically designates, as small construction activity under the NPDES stormwater permitting program, all operators of construction site activities that result in a land disturbance of equal to or greater than one and less than five acres. Site activities that disturb less than one acre are also regulated as small construction activity if they are part of a larger common plan of development or sale with a planned disturbance of equal to or greater than one acre and less than five acres, or if they are designated by the NPDES permitting authority. The NPDES permitting authority or U.S. EPA Region may designate construction activities disturbing less than one acre based on the potential for contribution to a violation of a water quality standard or for significant contribution of pollutants to waters of the United States.

The Construction General Permit authorizes the discharge of stormwater to surface waters from construction activities. The Construction General Permit requires that all developers of land where construction activities will occur over more than one acre to develop and implement a Stormwater Pollution Prevention Plan (SWPPP), which specifies Best Management Practices (BMPs) that will reduce pollution in stormwater discharges to the Best Available Technology Economically Achievable/Best Conventional Pollutant Control Technology standards; and, perform inspections and maintenance of all BMPs. Typical BMPs contained in SWPPPs are designed to minimize erosion during construction, stabilize construction areas, control sediment, control pollutants from construction materials, and address post construction runoff quantity (volume) and quality (treatment). The SWPPP must also include a discussion of the program to inspect and maintain all BMPs.

3.4.2.2.3 Drinking Water Standards

The California Safe Drinking Water Act, enacted in 1976, is codified in Title 22 of the CCR. The California Safe Drinking Water Act provides for the operation of public water systems and imposes various duties and responsibilities for the regulation and control of drinking water in the State of California including enforcing provisions of the federal Safe Drinking Water Act. The California Safe Drinking Water Program was originally implemented by the California Department of Public Health until July 1, 2014 when the program was transferred to the SWRCB via an act of legislation, SB 861. This transfer of authority means that the SWRCB has regulatory and enforcement authority over drinking water standards and water systems under Health and Safety Code §116271.

Potable water supply is managed through the following agencies and water districts: the California Department of Water Resources (CDWR), the California Department of Health Services (DHS), the SWRCB, the U.S. EPA, and the U.S. Bureau of Reclamation. Water right applications are processed through the SWRCB for properties claiming riparian rights. The CDWR manages the State Water Project (SWP) and compiles planning information on water supply and water demand within the state. Primary drinking water standards are promulgated in the CWA §304 and these standards require states to ensure that potable water retailed to the public meets these standards. Standards for a total of 88 individual constituents, referred to as Maximum Contaminant Levels (MCLs), have been established under the Safe Drinking Water Act as amended in 1986 and 1996. The U.S. EPA may add additional constituents in the future. The MCL is the concentration that is not anticipated to produce adverse health effects after a lifetime of exposure. State primary and secondary drinking water standards are codified in CCR Title 22 §§64431 - 64501. Secondary drinking water standards incorporate non-health risk factors including taste, odor, and appearance. The 1991 Water Recycling Act established water recycling as a priority in California. The Water Recycling Act encourages municipal wastewater treatment districts to implement recycling programs to reduce local water demands. The DHS enforces drinking water standards in California.

3.4.2.2.4 Sustainable Groundwater Management Act

The Sustainable Groundwater Management Act was enacted in September 2014. The Act provides for the management and use of groundwater in a manner that can be maintained during a 50-year planning and implementation horizon without causing undesirable results. The Act establishes a structure for locally managing California's groundwater and includes the following key elements: (1) provides for the establishment of a Groundwater Sustainability Agency; (2) requires all groundwater basins found to be of "high" or "medium" priority to prepare Groundwater Sustainability Plans (Sonoma, Napa, Solano, Contra Costa, Alameda and Control Costa Counties include basins designed as high or medium priority); (3) provides for the proposed revisions, by local agencies, to the boundaries of a basin; (4) provides authority to adopt regulations to evaluate Groundwater Sustainability Plans and review them for compliance every five years; (5) requires that Best Management Practices and technical measures be developed to implement Groundwater Sustainability Plans; and (6) provides the regulatory authority for the SWRCB to implement interim groundwater monitoring programs under certain circumstances.

3.4.2.2.5 Wastewater Treatment Regulations

The federal government enacted the CWA to regulate point source water pollutants, particularly municipal sewage and industrial discharges, to waters of the United States through the NPDES permitting program. In addition to establishing a framework for regulating water quality, the CWA authorized a multibillion dollar Clean Water Grant Program, which together with the California Clean Water Bond funding, assisted communities in constructing municipal wastewater treatment facilities. These financing measures made higher levels of wastewater treatment possible for both large and small communities throughout California, significantly improving the quality of receiving waters statewide. Wastewater treatment and water pollution control laws in California are codified in the CWC and CCR, Titles 22 and 23. In addition to federal and state restrictions on wastewater discharges, most incorporated cities in California have adopted local ordinances for wastewater treatment facilities. Local ordinances generally require treatment system designs to be reviewed and approved by the local agency prior to construction. Larger urban areas with elaborate infrastructure in place would generally prefer new developments to hook into the existing system rather than construct new wastewater treatment facilities. Other communities promote individual septic systems to avoid construction of potentially growth accommodating treatment facilities. The RWQCBs generally delegate management responsibilities of septic systems to local jurisdictions. Regulation of wastewater treatment includes the disposal and reuse of biosolids.

3.4.2.2.6 California Department of Fish and Wildlife

The California Department of Fish and Wildlife is responsible for conserving, protecting, and managing California's fish, wildlife, and native plant resources. To meet this responsibility, the Fish and Game Code (Section 1602) requires an entity to notify the Department of any proposed activity that may substantially modify a river, stream, or lake. The notification requirement applies to any work undertaken in or near a river, stream, or lake that flows at least intermittently through a bed or channel. This includes ephemeral streams, desert washes, and watercourses with a subsurface flow. It may also apply to work undertaken within the flood plain of a body of water.

3.4.2.3 Local Regulations

3.4.2.3.1 McAteer-Petris Act/San Francisco Bay Conservation and Development Commission

The McAteer-Petris Act is a provision under California law that preserves San Francisco Bay from indiscriminate filling. The Act established the San Francisco Bay Conservation and Development Commission (BCDC) as the agency charged with preparing a plan for the long-term use of the Bay and regulating development in and around the Bay while the plan was being prepared. The San Francisco Bay Plan, completed in January 1969, includes policies on 18 issues critical to the wise use of the bay, ranging from ports and public access to design considerations and weather. The McAteer-Petris Act authorizes BCDC to incorporate the policies of the Bay Plan into state law. The Bay Plan has two features: policies to guide future uses of the bay and shoreline, and maps that apply these policies to the bay and shoreline. BCDC conducts the regulatory process in accordance with the Bay Plan policies and maps, which guide the protection and development of the bay and its tributary waterways, marshes, managed wetlands, salt ponds, and shoreline.

3.4.2.3.2 General Plan Elements

The conservation, open space and safety elements are the most relevant of the general plan elements to hydrology and water quality. The conservation element typically addresses watershed protection, land or water reclamation, prevention or control of the pollution of streams and other coastal waters, regulation of land uses along stream channels and in other areas required to implement the conservation plan (e.g., buffer areas), to control or correct soil erosion, and for flood control. The open space element applies to the preservation of natural resources, including fish and wildlife habitat, rivers, streams, bays and estuaries, and open space.

3.4.2.3.3 Other Local Regulations

In addition to federal and state regulations, cities, counties and water districts may also provide regulatory advisement regarding water resources. Many jurisdictions incorporate policies related to water resources in their municipal codes, development standards, storm water pollution prevention requirements, and other regulations.

3.4.3 SIGNIFICANCE CRITERIA

The proposed project impacts on hydrology and water quality would be considered significant if the following occurs:

Water Demand:

- The existing water supply does not have the capacity to meet the increased demands of the project, or the project would use more than 263,000 gallons per day of potable water.

Water Quality:

- The project will cause degradation or depletion of ground water resources substantially affecting current or future uses.
- The project will cause the degradation of surface water substantially affecting current or future uses.
- The project will result in a violation of NPDES permit requirements.
- The capacities of existing or proposed wastewater treatment facilities and the sanitary sewer system are not sufficient to meet the needs of the project.

3.4.4 ENVIRONMENTAL IMPACTS

Under the Expedited BARCT Implementation Schedule, industrial sources that participate in the GHG Cap-and-Trade system in the Bay Area would be required to expedited BARCT to reduce criteria pollutant emissions. As discussed in the NOP/IS (see Appendix A), additional water demand and wastewater generation impacts are expected to result from the operation of several of the possible control technologies that would most likely be used (see Table 3.4-3).

3.4.4.1 Potential Water Demand Impacts

It is expected that affected industrial facilities would install new or modify existing air pollution control equipment to comply with the Expedited BARCT Implementation Schedule. Most air pollution control equipment does not use water or generate wastewater (see Table 3.4-4). However, additional water demand and wastewater generation impacts are expected to result from the operation of wet gas scrubbers (or LoTOX), which may be used to control refinery FCCUs and coke calciners, and water usage to make the lime slurry to control emissions from the cement kiln (see Table 3.4-4).

Demolition and construction activities to install air pollution control equipment have the potential to generate potential water demand and water quality impacts. For example, water is used during construction to reduce fugitive dust from any site preparation or grading activities. Potential water demand and water quality impacts during potential future construction activities will be evaluated in the subsections below.

Table 3.4-4 shows air pollution control equipment that are expected to be required under the Expedited BARCT Implementation Schedule. As shown in Table 3.4-4, not all control technologies use water as part of the emission control process and, therefore, would not be expected to contribute to water demand or water quality impacts. These control technologies, which includes domes on storage tanks, increased LDAR, and SO_2 Reducing Catalysts, will not be considered further in this analysis. Analyses of water demand and water quality impacts from control equipment that do use water as part of the control process are provided in the following subsections.

3.4.4.1.1 Dust Suppression Associated with Construction Activities

Installation of some types of relatively small air pollution control equipment, e.g., thermal incinerators, vapor recovery units and vapor combustors, are not expected to require site preparation activities because the equipment is generally not very large and could often be constructed onto existing foundations. In the event that some site preparation is necessary for these types of control technologies, plots would be small in area, thus, requiring little water for fugitive dust control. Therefore, little or no water for dust suppression purposes is expected to be needed for construction of thermal incinerators, vapor combustors, or vapor recovery units.

TABLE 3.4-4

Potential Control Technologies and Potential Water Use and Wastewater Generation during Equipment Operations

Potential Control Technology	Uses Water?	Exceeds threshold?	Generates Wastewater?	Exceeds Threshold?
Domes on Storage Tanks	No	No	No	No
Vapor Recovery Unit	No	No	No	No
Thermal Incinerator	No	No	No	No
Vapor Combustor	No	No	No	No
Additional Lime Injection	Yes	No	No	No
Wet Gas Scrubbers	Yes	Yes	Yes	No
Electrostatic Precipitator (Dry)	No	No	No	No
Electrostatic Precipitator (Wet)	Yes	No	Yes	No
Increased LDAR	No	No	No	No
SO_2 Reducing Catalyst	No	No	No	No
LoTOX^{TM}	Yes	Yes	Yes	No
Selective Catalytic Reduction	No	No	No	No

For larger air pollution control equipment, e.g., ESPs, WGSs (including LoTOx) and SCRs, site preparation activities requiring water for dust control would likely be necessary. For example, it is assumed that one water truck per affected refinery may be needed for dust suppression activities during the initial site preparation/earth moving to install large air pollution control equipment. One water truck used for dust control can hold approximately 6,000 gallons and it can be refilled over the course of the day if more than 6,000 gallons is needed. A WGS is one of the largest types of potential air pollution control equipment that could be installed as part of the Expedited BARCT Implementation Schedule. A typical WGS system could require an area of approximately 6,000 square feet. By applying one gallon of water per square foot of disturbed area, at a minimum of two times per day to minimize fugitive dust, the total amount of water expected to be used for dust suppression is approximately 12,000 gallons per day for each affected facility. Installation of the controls required under the Schedule might include large construction projects that involve site preparation activities requiring water for dust control, such as construction of LoTOx or SCR at the coke calciner; ESPs or WGS units at two refinery FCCUs for reducing particulate matter emissions; and a WGS at a third refinery FCCU for reducing particulate matter and SO_2 emissions. Table 3.4-5 summarizes the potential water demand associated with the potential overlap of site preparation/earth moving activities. While the actual construction and site preparation/earth moving activities that may occur under the Expedited BARCT Implementation Schedule may not overlap, it is reasonable to assume that there is a potential for overlap due to the process and time restraints placed by the individual rule development projects. As shown, even in the unlikely event that site preparation/earth moving activities for four construction projects were to coincide and each use water simultaneously, an estimated 48,000 gallons per day of water would be expected to be used for dust suppression activities, which would be less than the significance threshold for water demand. This analysis assumes that all water used for dust suppression activities is potable water. It is likely that the affected facilities have access to reclaimed water supplies, which could be used instead of potable water for dust suppression activities. Finally, once construction is complete, water demand for fugitive dust control activities would cease.

TABLE 3.4-5

Estimated Water Use During Construction of Control Equipment

Air Pollution Control Equipment	Estimated Size of Grading (sq ft)	Estimated Water Needed for Dust Suppression (gal/day)
Individual Refinery WGS, LoTOx, SCR, or ESP (1 Unit)	6,000	12,000
Potential Overlapping Site Preparation/Earth Moving Activities		
Refinery WGS or ESP (3 Units)	18,000	36,000
Coke calciner SCR (1 Unit)	6,000	12,000
Total	**-**	**48,000**
Significance Threshold	**-**	**263,000**
Significant?	**-**	**No**

3.4.4.1.2 Operation

<u>Additional Lime Injection</u>

Hydrated lime is mixed with water to create a slurry for use in the cement kiln for emission control. It is assumed that the cement kiln will use a 25 percent hydrated lime solution, the same concentration that is currently used at the facility; however, increased lime injection will be used to remove SO_2 emissions. The use of approximately 5,800 tons per year of lime, would result in the increased use of 4,752,000 gallons per year or approximately 13,000 gallons per day. The water use for the existing lime injection system is from the plant's reclaimed water system. It is expected that some or all of the increase in water use for the increase in lime injection would come from the reclaimed water system as well; however, for this EIR, it is conservatively assumed that the increase in water use is potable water.

<u>Wet Electrostatic Precipitator</u>

Installation of ESPs may occur under the Expedited BARCT Implementation Schedule. ESPs could be used to control PM emissions from FCCUs. Dry ESPs require no water, while wet ESP use water spray/mist to entrain the particulates and remove them from the gas stream.

The SCAQMD required additional control of particulates from FCCUs at refineries in southern California. All refineries installed new dry ESPs or upgraded existing dry ESPs, and one refinery installed a WGS and wet ESP to comply with SCAQMD Rule 1105.1. Wet ESPs are used in situations for which dry ESPs are not suited, such as when the material to be collected is wet, sticky, flammable, explosive, or has high resistivity (U.S. EPA, 2018). The use of dry ESPs would not require water usage. The use of wet ESPs would require additional water, which is used as part of the emission control process. Instead of potable water, it is likely that each affected refinery operator would utilize strip sour water or similar existing treated waste process water from elsewhere within each refinery. Because existing sources of wastewater, e.g., strip sour water or similar existing treated wastewater, could be used to operate a wet ESP, demand from installing new add-on control equipment would be minimal. In addition, wastewater from the wet ESP can be treated and recycled back to the wet ESP, further minimizing water demand impacts. Thus, the impacts of installing ESPs on future water demand at an affected facility are not expected to exceed any applicable water demand significance thresholds because dry ESPs are more likely to be utilized.

<u>Wet Gas Scrubber – Operation</u>

One wet ESP and WGS were installed on the FCCU at the Phillips 66 Los Angeles Refinery to control sulfur oxide emissions, as well as PM_{10} and $PM_{2.5}$ emissions. The environmental analysis for this project indicated that the expected water demand associated with the WGS was about 300 gallons per minute (432,000 gallons per day) (SCAQMD, 2007). WGS systems of this size are primarily designed for large emission sources (e.g., refineries and other large manufacturing facilities). The water demand from LoTOx, which operates similar to a wet scrubber, is expected to be similar to a WGS. The water demand from one new WGS of this size would exceed the CEQA significance threshold for water demand of 263,000 gallons per day. District staff has estimated that up to three WGS systems, one LoTOx system, and additional lime injection may be implemented to comply with the Expedited BARCT Implementation Schedule. If all three WGS are required, along with one LoTOx unit and additional lime injection, the total water usage is estimated to be up to 1,741,000 gal/day, as summarized in Table 3.4-6. Therefore, operational impacts to water demand are considered to be significant.

TABLE 3.4-6

Estimated Operational Water Use of Expedited BARCT Implementation Schedule

Equipment	Estimated Operational Water Use (gal/day)
Refinery WGS (3 Units)	1,296,000
Coke Calciner LoTOX	432,000
Cement Kiln Lime Injection	13,000(1)
Maximum Daily Water Usage	**1,741,000**
Significance Threshold	**263,000**
Significant?	**Yes**

(1) A portion of this water is expected to be reclaimed water.

<u>Conclusion</u>

Based upon the above considerations, water demand impacts from installing three WGS on refinery FCCUs, a LoTOX on a coke calciner, and additional lime injection at a cement kiln may exceed applicable water demand significance thresholds and, therefore, water demand impacts are concluded to be significant.

3.4.4.2 Potential Water Quality Impacts

Increased demand for water from the various control technologies generally will be proportional to any increases in wastewater generation from affected facilities; however, there are a number of factors that affect wastewater generation. As with quantifying water demand, there is insufficient information available to calculate the volumes of wastewater from control equipment for the following reasons. First, not all of the additional water demand generated by installing air pollution control equipment would ultimately be discharged as wastewater. In some control systems, a portion of the increased water demand would be emitted as steam or would evaporate during the control process. To determine this evaporation rate, it is necessary to know the operating temperature and humidity in the vicinity of the equipment, which are currently unknown. In addition, wastewater discharge requirements under a facility's Industrial Wastewater Discharge Permit (IWDP) and current wastewater discharge rates need to be known. To the extent possible and based on available information, water quality impacts from air pollution control technologies that use water as part of the control process are evaluated in the following subsections.

3.4.4.2.1 Construction Activities

Water used for dust suppression activities typically wets the top one to two inches of soil, evaporates and then forms a soil crust. As a result, this water does not flow into storm drains, sewers or other water collection systems and, therefore, water runoff from dust suppression activities would not be expected to occur and water quality impacts from dust suppression activities are concluded to be less than significant.

3.4.4.2.2 Operation

Since additional water would be needed as part of certain types of air pollution control equipment, the proposed project could increase the wastewater generated by each affected facility. The cement kiln uses lime injection in the form of lime slurry, where powder hydrated lime is mixed with water to create a 25 percent hydrated lime solution. The slurry is sprayed together with the conditioning water into the kiln's exhaust flue gas. The water in the hydrated lime slurry is then evaporated by the hot gases. Therefore, the water used to make the slurry is not expected to result in any additional wastewater discharges because the water is evaporated in the kilns.

Wastewater from WGS, ESP, and LoTOx systems is collected and flows into a sump where it is typically treated. The wastewater is treated in the facility's wastewater treatment plant and then discharged or recycled to minimize the water demand and wastewater generated from the equipment.

Depending on the facility's wastewater treatment system, the effluent may be further treated and discharged to the sanitary sewer system. WGS, ESP, and LoTOx systems would be used on

FCCUs or coke calciners, which currently have wastewater discharges and wastewater treatment systems. Depending on the type of WGS or LoTOx, some water may be lost as steam. For these reasons, it is not expected that wastewater would exceed a facility's current wastewater discharge limits, require changes to existing wastewater permit conditions, or require new wastewater permits. Refineries are large users of water, have large wastewater discharges, and have large wastewater treatment facilities. Changes to existing permit conditions would not likely be required and no violations of existing IWDPs, NPDES permits, or other wastewater permit limits are expected. Wastewater discharges from an industrial facility would be required to be discharged in compliance with applicable wastewater discharge permits. Therefore, water quality impacts from the operation of WGS, ESP, and LoTOx systems are not expected to exceed any applicable water quality significance thresholds, so water quality impacts during operation are concluded to be less than significant.

Once recycled, wastewater generated by the WGS, ESP, and LoTOx systems can also be returned to the equipment for reuse, which would reduce the total amount of water required for air pollution control, as well as the amount of wastewater discharged into the sewer system.

3.4.4.3 Conclusion

Based upon the above considerations, water quality impacts from installing most types of air pollution control equipment that use water as part of the control process would not exceed applicable water quality significance thresholds and, therefore, are concluded to be less than significant.

3.4.5 MITIGATION MEASURES

3.4.5.1 Water Demand

Because it was concluded that if wet gas scrubbers, additional lime injection, and LoTOx systems are installed as a response to the Expedited BARCT Implementation Schedule, potential future water demand impacts from the proposed systems during operation would be significant, mitigation measures for water demand are required. Therefore, for any affected facility that installs an air pollution control technology that increases demand for water, the following water demand mitigation measures will apply.

HWQ-1 When air pollution control equipment is installed and water is required for its operation, the facility is required to use recirculated, reclaimed, or recycled water, if available, to satisfy the water demand for the air pollution control equipment.

HWQ-2 In the event that reclaimed or recycled water cannot be delivered to the affected facility, the facility is required to submit a written declaration with the application for a Permit to Construct for the air pollution control equipment, to be signed by an official of the water purveyor indicating the reason(s) why reclaimed or recycled water cannot be supplied to the project.

3.4.5.2 Remaining Impacts

In spite of implementing the mitigation measures identified above, water demand impacts during operation of the proposed project remain significant, in part because there is currently no guarantee that reclaimed water will be available to all of the affected facilities and because of the prevalence of drought conditions in California. The use of recirculated, reclaimed, or recycled water may be able to reduce water demand from these control systems, however, the availability and feasibility of procuring and using these water sources in the future is not currently known, and would be dependent on the individual equipment design and site-specific considerations of water availability. Therefore, impacts associated with the proposed project will remain significant after mitigation for water demand.

With regard to water quality, it was concluded that impacts would be less than significant, so no mitigation measures are required.

3.4.6 CUMULATIVE IMPACTS

In the above analyses of construction water demand and water quality it was concluded that impacts would be less than significant. Similarly, it was concluded that water quality impacts from the proposed project during operation would be less than significant. Therefore, because construction water quality and water demand impacts and operational water quality impacts were concluded to be less than significant, they are not considered to be cumulatively considerable (CEQA Guidelines §15064 (h)(1)) and, therefore are not expected to generate significant adverse cumulative impacts for these environmental topic areas.

In the above analysis of water demand impacts from the proposed project during operation it was concluded that installing WGS, additional lime injection, and LoTOx systems has the potential to generate significant adverse operational water demand impacts. Therefore, operational water demand impacts during operation of the proposed project are considered to be cumulatively considerable for the Expedited BARCT Implementation Schedule (CEQA Guidelines §15064 (h)(1)).

CHAPTER 3.5

OTHER CEQA SECTIONS

Growth Inducing Impacts
Significant Environmental Effects Which Cannot Be Avoided And Significant Irreversible Environmental Changes
Potential Environmental Impacts Found Not to be Significant

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3.5 OTHER CEQA SECTIONS

3.5.1 GROWTH INDUCING IMPACTS

3.5.1.1 Introduction

CEQA defines growth-inducing impacts as those impacts of a proposed project that "could foster economic or population growth, or the construction of additional housing, either directly or indirectly, in the surrounding environment. Included in this are projects, which would remove obstacles to population growth" (CEQA Guidelines §15126.2(d)).

To address this issue, potential growth-inducing effects are examined through the following considerations:

- Facilitation of economic effects that could result in other activities that could significantly affect the environment;
- Expansion requirements for one or more public services to maintain desired levels of service as a result of the proposed project;
- Removal of obstacles to growth, e.g., through the construction or extension of major infrastructure facilities that do not presently exist in the project area or through changes in existing regulations pertaining to land development;
- Adding development or encroachment into open space; and/or
- Setting a precedent that could encourage and facilitate other activities that could significantly affect the environment.

3.5.1.2 Economic and Population Growth, and Related Public Services

The Expedited BARCT Implementation Schedule would not directly foster economic or population growth or the construction of new housing in the Bay area. The Expedited BARCT Implementation Schedule may require construction of air pollution control equipment or operational measures/modifications within the confines of the existing industrial facilities but would not be expected to involve new development outside of existing facilities. Therefore, it would not stimulate significant population growth, remove obstacles to population growth, or necessitate the construction of new community facilities that would lead to additional growth.

A project would directly induce growth if it would directly foster economic or population growth or the construction of new housing in the surrounding environment (e.g., if it would remove an obstacle to growth by expanding existing infrastructure). The proposed rule amendments would not remove barriers to population growth, as it involves no changes to General Plan, zoning ordinance, or related land use policy. The proposed rule amendments do not include the development of new housing or population-generating uses or infrastructure that would directly encourage such uses. Therefore, the Expedited BARCT Implementation Schedule would not directly or indirectly trigger new residential development in the District.

Further, the Expedited BARCT Implementation Schedule would not result in an increase in local population, housing, or associated public services (e.g. fire, police, schools, recreation, and library facilities) since the proposed project would not result in an increase in permanent workers or residents. Additional workers would be limited to temporary construction workers. Likewise, the proposed project would not create new demand for secondary services, including regional or specialty retail, restaurant or food delivery, recreation, or entertainment uses. As such, the proposed project would not foster economic or population growth in the surrounding area in a manner that would be growth-inducing.

3.5.1.3 Removal of Obstacles to Growth

The Expedited BARCT Implementation Schedule would not employ activities or uses that would result in growth inducement, such as the development of new infrastructure (i.e., new roadway access or utilities, such as wastewater treatment facilities) that would directly or indirectly cause the growth of new populations, communities, or currently undeveloped areas. Likewise, the Expedited BARCT Implementation Schedule would not result in an expansion of existing public service facilities (e.g., police, fire, libraries, and schools) or the development of public service facilities that do not already exist.

3.5.1.4 Development of Encroachment Into Open Space

Development can be considered growth-inducing when it is not contiguous to existing urban development and introduces development into open space areas. The Expedited BARCT Implementation Schedule may require additional air pollution control equipment and measures within the confines of existing facilities and existing industrial areas. New development outside of the boundaries of industrial facilities is not expected to occur. Therefore, the proposed rule amendments would not result in development within or encroachment into an open space area.

3.5.1.5 Precedent Setting Action

The Expedited BARCT Implementation Schedule would lead to further control of criteria pollutant emissions. The type of control equipment that would be implemented as part of the proposed project (e.g., SCRs, ESPs, thermal oxidizers, WGS, etc.) has been used and proven to be effective at other industrial facilities. Requiring technologies and measures that have been demonstrated to be effective to control air emissions from the affected industrial facilities would not result in precedent-setting actions that might cause significant environmental impacts.

3.5.1.6 Conclusion

The Expedited BARCT Implementation Schedule would not be considered growth-inducing, because they would not result in an increase in production of resources or cause a progression of growth that could significantly affect the environment either individually or cumulatively.

3.5.2 SIGNIFICANT ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED AND SIGNIFICANT IRREVERSIBLE ENVIRONMENTAL CHANGES

Section 15126.2(b) of the CEQA Guidelines requires that an EIR describe significant environmental impacts that cannot be avoided, including those effects that can be mitigated but not reduced to a less than significant level. As evaluated in the preceding portions of Chapter 3 of this EIR, the proposed rule amendments would result in potentially significant unavoidable impacts as identified in Table 3.5-1.

TABLE 3.5-1

IMPACTS IDENTIFIED AS POTENTIALLY SIGNIFICANT IN THIS EIR FOR IMPLEMENTATION OF THE EXPEDITED BARCT IMPLEMENTATION SCHEDULE

POTENTIALLY SIGNIFICANT IMPACTS
ROG, NOx, PM_{10}, and $PM_{2.5}$ Emission Impacts During Construction
Water Demand Impacts

3.5.3 POTENTIAL ENVIRONMENTAL IMPACTS FOUND NOT TO BE SIGNIFICANT

The environmental effects of the Expedited BARCT Implementation Schedule that may have potentially significant adverse effects on the environment are identified, evaluated, and discussed in detail in the preceding portions of Chapter 3 of this EIR and in the Initial Study (see Appendix A) per the requirements of the CEQA Guidelines (§§15126(a) and 15126.2). The potentially significant adverse environmental impacts as determined by the Initial Study (see Appendix A) are: air quality, hazards and hazardous materials, hydrology and water quality, and utilities and service systems. The water demand impacts were determined to be significant under hydrology/water quality and utilities/services. To avoid repetition, the water demand impacts have been consolidated under the hydrology and water quality impacts section in Chapter 3.4 of this EIR. The analysis provided in the Initial Study has concluded that impacts on the following environmental topics would be less than significant: aesthetics; agriculture and forestry resources; biological resources; cultural resources; geology and soils; greenhouse gas emissions, land use and planning; mineral resources; noise; population and housing; public services; recreation; transportation and traffic; tribal cultural resources; and utilities and service systems. The reasons for finding impacts to the environmental resources to be less than significant are explained in the following subsections, which are summarized from the NOP/IS (see Appendix A) unless otherwise noted.

3.5.3.1 Aesthetics

Physical modifications at facilities due to installation of BARCT are expected to be limited to industrial facilities. Air pollution control equipment or measures would be constructed/implemented within the confines of the existing industrial facilities and adjacent to existing industrial structures. Some BARCT measures are not expected to be visible outside of the existing facility. This would include covering portions of petroleum wastewater treatment facilities, lime injection at cement plants, use of SO_2 reducing catalysts, and increased LDAR.

Other BARCT measures would include the installation of equipment that may be visible outside of the existing industrial facilities, however, these facilities are located in industrial areas which do not have scenic views or scenic resources. For example, domes on storage tanks increase the height of the storage tanks making them more visible to the areas surrounding the storage tanks. However, storage tanks are generally located at refineries, bulk handling and storage facilities, or manufacturing facilities and are located within industrial areas. Thus, they are not expected to have significant adverse aesthetic impacts to the surrounding community. Additionally, new air pollution control equipment is not expected to block any scenic vista, degrade the visual character or quality of the area, or result in significant adverse aesthetic impacts.

The industrial facilities affected by the Expedited BARCT Implementation Schedule may need to install or modify air pollution control equipment to reduce criteria pollutant emissions from their facilities. These facilities are existing industrial facilities that currently operate or can operate 24 hours a day and have existing lighting for nighttime operations. For example, refineries operate continuously 24 hours per day, 7 days per week and are already lighted for nighttime operations. The same is true for most other types of manufacturing operations. Therefore, the Expedited BARCT Implementation Schedule is not expected to require any additional lighting to be installed as a result of new air pollution control equipment or control measures. New light sources, if any, would be located in industrial areas and are not expected to be noticeable in residential areas. Most local land use agencies have ordinances that limit the intensity of lighting and its effects on adjacent property owners. Therefore, the Expedited BARCT Implementation Schedule is not expected to have significant adverse aesthetic impacts to the surrounding community.

3.5.3.2 Agriculture and Forestry Resources

Physical modifications at facilities due to the proposed project are expected to be limited to industrial facilities. Air pollution control equipment or measures would be constructed/implemented within the confines of the existing industrial facilities and adjacent to existing industrial structures. This equipment would be compatible with the existing industrial character of the area and would not be located in agricultural or forestland areas. Thus, no impacts to agriculture and forestry resources are expected.

The proposed project would not conflict with existing agriculture related zoning designations or Williamson Act contracts. Existing agriculture and forest resources within the boundaries of the Air District are not expected to be affected by the construction of additional air pollution control equipment or modification to existing emission sources. Therefore, there is no potential for conversion of farmland to non-agricultural use or conflicts related to agricultural uses or land under a Williamson Act contract, or impacts to forestland resources.

3.5.3.3 Biological Resources

Physical modifications at facilities due to the Expedited BARCT Implementation Schedule are expected to be limited to industrial facilities. Air pollution control equipment or measures would be constructed/implemented within the confines of the existing industrial facilities and adjacent to existing industrial structures. These facilities have been built and graded and no major grading would be expected to occur due to the installment of additional air pollution control equipment. Construction activities would occur within industrial areas, where native biological resources have been removed or are non-existent. Thus, the proposed project is not expected to result in any impacts to biological resources.

The proposed project is not expected to affect land use plans, local policies or ordinances, or regulations protecting biological resources such as a tree preservation policy or ordinances for the reasons already given. Land use and other planning considerations are determined by local governments and land use or planning requirements are not expected to be altered by the proposed project. Similarly, the Expedited BARCT Implementation Schedule is not expected to affect any habitat conservation or natural community conservation plans, biological resources or operations, and would not create divisions in any existing communities, as construction activities would be limited to existing facilities in industrial areas that have already been developed and graded.

3.5.3.4 Cultural Resources

Generally, resources (buildings, structures, equipment) that are less than 50 years old are excluded from listing in the National Register of Historic Places unless they can be shown to be exceptionally important. The Expedited BARCT Implementation Schedule would result in control measures and new air pollution control equipment to be constructed within the confines of the existing industrial facilities and adjacent to existing industrial structures. Affected facilities may have equipment or structures older than 50 years, however, this type of equipment does not meet the criteria identified in CEQA Guidelines §15064.5(a)(3). Further, construction activities associated with the proposed project are expected to be limited to industrial areas that have already been developed. Thus, the Expedited BARCT Implementation Schedule would not adversely affect historical or archaeological resources as defined in CEQA Guidelines §15064.5, destroy unique paleontological resources or unique geologic features, or disturb human remains interred outside formal cemeteries. Therefore, no impacts to cultural resources are anticipated to occur as a result of the proposed project as no major construction activities are required.

3.5.3.5 Geology and Soils

Physical modifications at facilities due to the Expedited BARCT Implementation Schedule are expected to be limited to industrial facilities. New development potentially resulting in earthquake hazards are expected to be limited to the construction of air pollution control equipment or measures at industrial facilities. New construction (including modifications to existing structures) requires compliance with the California Building Code. The California Building Code is considered to be a standard safeguard against major structural failures and loss of life. The goal of the code is to provide structures that will: (1) resist minor earthquakes without damage; (2) resist moderate earthquakes without structural damage, but with some non-structural damage; and (3) resist major earthquakes without collapse, but with some structural and non-structural damage. The California Building Code bases seismic design on minimum lateral seismic forces ("ground shaking"). The California Building Code requirements operate on the principle that providing appropriate foundations, among other aspects, helps to protect buildings from failure during earthquakes. The basic formulas used for the California Building Code seismic design require determination of the seismic zone and site coefficient, which represent the foundation conditions at the site. Compliance with the California Building Code would minimize the impacts associated with existing geological hazards.

Construction associated with the proposed project is expected to be limited to air pollution control equipment at industrial facilities. All construction would take place at already existing facilities that have been previously graded. Thus, the proposed project is not expected to result in substantial soil erosion or the loss of topsoil as construction activities are expected to be limited to existing operating facilities that have been graded and development, so that no major grading would be required.

3.5.3.6 Greenhouse Gas Emissions

While the primary purpose of the Expedited BARCT Implementation Schedule is to reduce emissions of ROG, NOx, SO_2, and PM, some types of control equipment have the potential to create secondary adverse air quality impacts and create GHG emissions, through construction activities or through the additional of air pollution control equipment. The Expedited BARCT Implementation Schedule may result in the installation of new equipment at facilities that need to comply with the new requirements.

Limited construction activities may be required under the Expedited BARCT Implementation Schedule to enclose open fugitive components, install new catalyst, install lime injection systems, and so forth. Construction emissions associated with this type of construction would be minor and would involve the transport of the new equipment which is expected to require one to two truck trips. Installation of the equipment would be expected to be limited to one to two workers and would not require any major construction equipment and no site preparation activities are expected to be required. Therefore, retrofitting this type of existing equipment would result in minor construction emissions.

Construction activities would also be required for the construction of new air pollution control equipment at existing facilities, including vapor combustors, wet gas scrubbers, selective catalytic reduction, ESPs, vapor recovery systems, and LoTOX systems. The equipment associated with the Expedited BARCT Implementation Schedule would be required at existing facilities with large emission sources, e.g., refinery FCCUs. Construction activities for these types of new air pollution control equipment would be temporary. Each of these sources that might be subject to the Expedited BARCT Implementation are subject to the Cap-and-Trade Program and its greenhouse gas emissions are required to comply with the requirements of the Cap-and-Trade Programs. As a result, the greenhouse gas emission impacts resulting from the Expedited BARCT Implementation Schedule will be less than significant, since these emissions are part of a state plan aimed at reducing GHG emissions.

The facilities affected by the Expedited BARCT Implementation Schedule could require the installation of additional air pollution control equipment or the implementation of new measures to control criteria pollutants. These measures could generate additional GHG emissions. However, the facilities subject to the Expedited BARCT Implementation Schedule must comply with the Cap and Trade Program, a requirement that the Expedited BARCT Implementation

Schedule will not change. The Expedited BARCT Implementation Schedule will therefore have a less than significant impact on GHG emissions.

3.5.3.7 Land Use and Planning

Physical modifications at facilities due to the Expedited BARCT Implementation Schedule are expected to be limited to industrial facilities. Construction activities for new air pollution control equipment could be substantial for large facilities, e.g., FCCUs at refineries. However, construction activities would occur within the confines of existing industrial facilities that have already been graded and developed. Thus, the proposed project is not expected to have impacts to non-industrial land uses and would not result in impacts that would physically divide an established community.

The General Plans and land use plans for areas with industrial land uses, generally allow for and encourage the continued use of industrial areas within their respective communities. Some of the General Plans encourage the modernization of existing industrial areas, including refineries (Benicia, 2015 and Santa Clara, 2011). The construction of equipment within the confines of existing facilities is not expected to conflict with any applicable land use plan, policy or regulation of an agency with jurisdiction over the affected industrial facilities. The jurisdictions with land use approval recognize and support the continued use of industrial facilities. The construction required as part of the proposed project would not interfere with those land use policies or objectives.

The proposed project has no components which would affect land use plans, policies, or regulations. Regulating emissions from existing facilities will not require local governments to alter land use and other planning considerations. Habitat conservation or natural community conservation plans, agricultural resources or operations, would not be affected by the proposed project, and divisions of existing communities would not occur. Therefore, current or planned land uses within the District will not be significantly affected as a result of the proposed project.

3.5.3.8 Mineral Resources

Construction activities would occur within the confines of existing industrial facilities that have already been graded and developed. Construction of air pollution control equipment and modifications to existing industrial facilities as a result of the proposed project is not expected to affect mineral resources. Construction and operation of new equipment associated with proposed project is not expected to require mineral resources that are of value to the region or result in the loss of a locally important mineral resource site. Thus, no significant adverse impacts to mineral resources are expected.

3.5.3.9 Noise

Physical modifications at facilities due to installation of BARCT are expected to be limited to industrial facilities. Construction activities for new air pollution control equipment could be substantial for large facilities, e.g., FCCUs at refineries. However, construction activities would occur within the confines of existing industrial facilities and adjacent to existing industrial structures. The existing noise environment at each of the affected facilities is typically dominated by noise from existing equipment onsite, vehicular traffic around the facilities, and trucks entering and exiting facility premises. Construction required for the installation of air pollution control equipment or facility modifications is not expected to significantly alter the existing noise of an industrial facility. Construction activities associated with the proposed project would generate temporary noise associated with construction equipment and construction-related traffic. Construction would likely require truck trips to deliver equipment, construction workers, and construction equipment (e.g., forklift, welders, backhoes, cranes, and generators). All construction activities would be temporary, would occur during daylight hours, and would occur within the confines of existing industrial facilities so that no significant increase in noise during construction activities is expected.

Air pollution control equipment is not generally a major noise source. The equipment would be located within heavy industrial areas and compatible with such uses. Further, all noise producing equipment must comply with local noise ordnances and applicable OSHA and Cal/OSHA noise requirements. Therefore, industrial operations affected by the Expedited BARCT Implementation Schedule are not expected to have a significant adverse effect on local noise levels or noise ordinances.

The proposed project is not expected to generate or expose people to excessive groundborne vibration or groundborne noise. The use of large construction equipment that would generate substantial noise or vibration (e.g., backhoes, graders, jackhammers, etc.) would be limited because the sites are already graded and developed. Further, construction activities are temporary and would occur during the daylight hours, in compliance with local noise standards and ordinances. Therefore, the proposed project is not expected to generate excessive groundborne vibration or noise.

Affected facilities would still be expected to comply, and not interfere, with any applicable airport land use plans. None of the Expedited BARCT Implementation Schedule requirements would locate residents or commercial buildings or other sensitive noise sources closer to airport operations. There are no components of the Expedited BARCT Implementation Schedule that would substantially increase ambient noise levels within or adjacent to airports. Therefore, these topics will not be further evaluated in the EIR.

3.5.3.10 Population and Housing

The population in the Bay Area is currently about 7.6 million people and is expected to grow to about 9.6 million people by 2040 (ABAG, 2017). The proposed project is not anticipated to generate any significant effects, either directly or indirectly, on the Bay Area's population or population distribution. The proposed project will require construction activities to modify existing operations and/or install air pollution control equipment at existing industrial facilities. It is expected that the existing labor pool would accommodate the labor requirements for the construction of the new and modified industrial equipment. In addition, it is not expected that the affected facilities would need to hire additional personnel to operate new air pollution control equipment. In the event that 1-2 new employees are hired, the existing local labor pool in the District (over seven million people) can accommodate any increase in demand for workers that might occur as a result of adopting the Expedited BARCT Implementation Schedule. The proposed project is not expected to result in the creation of any industry/business that would affect population growth, directly or indirectly induce the construction of single- or multiple-family units, or require the displacement of people or housing elsewhere in the Bay Area.

3.5.3.11 Public Services

There is no potential for adverse public service impacts as a result of adopting the Expedited BARCT Implementation Schedule as it would not result in the need for new or physically altered government facilities to maintain acceptable service ratios, response times, or other performance objectives. Additionally, most of the affected refineries have on site security and fire protection personnel, so no increase in police or fire protection services is expected. Implementing the proposed rule would not cause a future population increase, thus it is not expected to affect land use plans, future development, or the demand for public facilities such as schools and parks.

3.5.3.12 Recreation

As discussed under "Land Use and Planning" and "Population and Housing," there are no provisions of the proposed project that would affect land use plans, policies, ordinances, or regulations as land use and other planning considerations are determined by local governments. No land use or planning requirements, including those relating to recreational facilities, will be altered by the proposed rule amendments. The proposed project does not have the potential to directly or indirectly induce population growth or redistribution. As a result, the proposed project would not increase the use of, or demand for, existing neighborhood or regional parks or other recreational facilities nor require the construction or expansion of recreational facilities that might have an adverse physical effect on the environment.

3.5.3.13 Transportation and Traffic

Physical modifications at facilities due the Expedited BARCT Implementation Schedule are expected to be limited to industrial facilities. Construction activities for new air pollution control equipment could be substantial for large facilities, e.g., FCCUs at refineries. However, construction activities would occur within the confines of existing industrial facilities and adjacent to existing industrial structures.

Construction would likely require truck trips to deliver equipment, construction workers, and construction equipment (e.g., forklift, welders, backhoes, cranes, and generators). All construction activities and related traffic would be temporary, would occur during daylight hours, would occur within the confines of existing industrial facilities, and would cease following the completion of construction. As discussed in "Population and Housing" above, the labor force in the Bay Area is sufficient to handle the temporary increase in construction-related jobs. No increase in permanent workers is expected due to the installation of additional air pollution control equipment or facility modifications. The installation of some air pollution control equipment, e.g., SCRs and wet gas scrubbers, could result in an increase of about 1-2 trucks per week to deliver ammonia, catalyst or caustic materials to the facilities for the operation of the equipment. The increase in one truck per day would be a negligible increase in traffic in the Bay Area.

The proposed project is not expected to affect the performance of mass transit or non-motorized travel to street, highways and freeways, pedestrian or bicycle paths, as no increase in permanent workers is expected. No conflicts with any congestion management programs, to include level of service and travel demand measures, or other standards established by county congestion management agencies for designated roads or highways are expected. No changes are expected to parking capacity at or in the vicinity of affected facilities as the proposed project only pertain to equipment located within existing industrial facilities. Therefore, no significant adverse impacts resulting in changes to traffic patterns or levels of service at local intersections are expected.

The Expedited BARCT Implementation Schedule is not expected to: (1) involve the delivery of materials via air so no increase in air traffic is expected or change air traffic patterns; (2) create traffic hazards or create incompatible uses; (3) impact emergency access at industrial facilities affected by the proposed project, as no modifications that effect traffic or access are expected to be required; (4) increase vehicle trips or to alter the existing long-term circulation patterns, thus creating traffic hazards; (5) affect the performance of mass transit or non-motorized travel to street, highways and freeways, pedestrian or bicycle paths as construction is expected to be limited to existing industrial facilities; (6) result in an increase in permanent workers; or (7) conflict with any congestion management programs or other plans, increase travel demand, impact public transit, or impact bicycle or pedestrian safety. Therefore, no impacts resulting in changes to traffic patterns or adopted traffic plans or programs are expected.

3.5.3.14 Tribal Cultural Resources

The proposed Expedited BARCT Implementation Schedule may require the construction of air pollution control equipment and facility modifications to industrial facilities. Affected facilities may have equipment or structures older than 50 years, however, this type of equipment does not meet the criteria identified in CEQA Guidelines §15064.5(a)(3), are not listed or eligible for listing in the California Register of Historic Resources or a local register of historical resources (Public Resources Code Section 5020.1(k), and are not considered to have cultural value to a California Native American tribe.

Construction associated with the proposed project is expected to be limited to the construction at industrial facilities. All construction would take place at existing facilities that have been previously graded. Because construction will be limited to facilities that have been graded, the Expedited BARCT Implementation Schedule is not expected to require physical changes to a site, feature, place, cultural landscape, sacred place or object with cultural value to a California Native American Tribe. The Expedited BARCT Implementation Schedule is not expected to result in a physical change to a resource determined to be eligible for inclusion or listed in the California Register of Historical Resources or included in a local register of historical resources.

As part of releasing the NOP/IS for public review and comment, the document was circulated to the State Clearinghouse that provides notice of the proposed project to all California Native American Tribes that requested to be on the Native American Heritage Commission's (NAHC) notification list per Public Resources Code § 21080.3.1(b)(1). The NAHC notification list provides a 30-day period during which a Native American Tribes may respond to the notice, in writing, requesting consultation on the Expedited BARCT Implementation Schedule. No tribes have requested consultation.

Since construction activities will be limited to existing industrial facilities, the Expedited BARCT Implementation Schedule is not expected to affect historical or tribal resources as defined in Public Resources Section 5020.1(k), or 5024.1. Therefore, no impacts to tribal resources are anticipated to occur as a result of the proposed project.

3.5.3.15 Utilities and Service Systems

The potential water use and wastewater impacts associated with the Expedited BARCT Implementation Schedule were discussed under Hydrology and Water Quality.

Air pollution control equipment and facility modifications to implement the Expedited BARCT Implementation Schedule would occur within the confines of existing industrial facilities where stormwater is already controlled. The proposed project is not expected to require additional paving that would generate additional stormwater runoff. Therefore, the proposed project would not be expected to alter the existing drainage systems or require the construction of new storm water drainage facilities. Nor would the proposed project create or contribute runoff water that would exceed the capacity of existing or planned storm water drainage systems or provide substantial additional sources of polluted runoff. Therefore, no significant adverse impacts on storm drainage facilities are expected.

Construction of air pollution control equipment as a result of the Expedited BARCT Implementation Schedule is not expected to significantly increase solid or hazards wastes generated by the affected existing facilities. Some air pollution control equipment uses catalysts that need to be replaced when it is depleted. The catalyst is usually recycled because of the metal content of the catalyst and would not be expected to generate additional hazardous or solid waste that requires disposal. Waste streams from affected facilities would be treated/disposed/recycled in the same manner as they currently are handled. Therefore, no significant impacts to hazardous or solid waste disposal facilities are expected due to the proposed project. Facilities are expected to continue to comply with all applicable federal, state, and local statutes and regulations related to solid and hazardous wastes.

While potential electricity and natural gas impacts were not discussed in the NOP/IS, this EIR provides a discussion of potential electricity and natural gas impacts. The California Energy Commission tracks both electricity and natural gas consumption for the state of California. A summary of the annual consumption of both electricity and natural gas is provided below in Table 3.5-2.

Table 3.5-2

Bay Area Natural Gas and Electricity Consumption, 2016[1]

County	Electricity (million kWH)	Natural Gas Use (million therms)
Alameda	10815	361
Contra Costa	9644	1136
Marin	1343	66
Napa	1058	36
San Francisco	5759	227
San Mateo	4340	200
Santa Clara	16777	421
Solano	3207	254
Sonoma	2965	106
Total	**55907**	**2807**

(1) CEC, 2018

A number of the rule development projects under the Expedited BARCT Implementation Schedule would require electricity as part of installing or modifying existing air pollution control equipment. Electricity could be utilized to operate certain construction equipment in lieu of diesel, such as welders and temporary lights, if electricity is available. Any additional electricity that may be needed as part of construction activities associated with the proposed project would typically be supplied by the local electrical utility; however, the majority of construction equipment is diesel-powered and does not require electricity. Thus, electricity use during construction activities would be minor.

Implementation of the Expedited BARCT Implementation Schedule would result in the installation of air pollution control equipment that would increase electricity use during operation. Table 3.5-3 provides estimates of electricity demand associated with the operation of the air pollution control equipment that would be expected as a result of the Expedited BARCT Implementation Schedule. Note that because ESPs have a higher electricity demand than WGS, ESP electricity demand was considered for this analysis to provide a conservative estimate.

Overall the electricity demand created by the proposed project is expected to be able to be met by local suppliers or the facility themselves as a number of refineries operate their own cogeneration units. The electricity would be used to further control emissions of criteria pollutants and assist the District in complying with ambient air quality standards; therefore, the electricity would not be used in a wasteful or inefficient manner. Thus, it is concluded the Expedited BARCT Implementation Schedule will not have a significant impact on electricity or use electricity in a wasteful manner.

Table 3.5-3

Annual Electricity Use of Air Pollution Control Equipment Associated with the Expedited BARCT Implementation Schedule

Control Equipment	Number of Units	Potential Increased Electricity Demand (MWhr/day)	Potential Increased Electricity Demand (Million kWH/yr)
WGS(1)	1	261	95.3
LoTox Scrubber(2)	1	261	95.3
SCR(2)	1	222	81.0
ESP(3)	2	803	293.1
Total		**1547**	**564.7**

(1) SCAQMD, 2007
(2) SCAQMD, 2015
(3) SCAQMD, 2007a

Of the air pollution control equipment that would be installed as a result of the Expedited BARCT Implementation Schedule, only vapor combustors, thermal incinerators, and vapor recovery units, collectively referred to as oxidizers, are expected to require the use of natural gas. The natural gas usage for one oxidizer is expected to be approximately 75 mmscf/yr. With a heating value of 1,050 mmbtu/scf and a total of 15 oxidizers expected to be installed as a result of the Expedited BARCT Implementation Schedule, the total natural gas usage is expected to be approximately 118 million therms/yr.

Overall, the natural gas use associated with the proposed project is expected to be met by local suppliers or the facility themselves as refineries general refinery fuel gas, which can be used in place of natural gas. The natural gas would be used to further control emissions of criteria pollutants and assist the District in complying with ambient air quality standards; therefore, the natural gas would not be used in a wasteful or inefficient manner. Thus, it is concluded the Expedited BARCT Implementation Schedule will not have a significant impact on natural gas or use natural gas in a wasteful manner.

CHAPTER 4

ALTERNATIVES ANALYSIS

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4.0 ALTERNATIVES ANALYSIS

4.1 DISCUSSION OF ALTERNATIVES

An EIR is required to describe a reasonable range of feasible alternatives to the proposed project that could feasibly attain most of the basic project objectives and would avoid or substantially lessen any of the significant environmental impacts of the proposed project (CEQA Guidelines §15126.6(a)). As discussed in Chapter 3 of this EIR the proposed project could result in significant impacts to air quality (ROG, NOx, PM_{10}, and $PM_{2.5}$) during construction activities and water demand associated with the operation of potential air pollution control equipment (WGS, LoTOX, and lime injection) associated with the Expedited BARCT Implementation Schedule. Therefore, alternatives analysis should focus on alternatives that avoid or minimize these potentially significant impacts. The project objectives are as follows:

1. Implement and/or install best available retrofit control technologies on industrial sources subject to CARB's Cap-and-Trade program, as defined by the AB 617 requirements;

2. Reduce criteria pollutant emissions from significant industrial sources that participate in CARB's Cap-and-Trade program;

3. Lessen the burden of air quality impacts on communities that suffer a disproportionate burden from air pollution; and

4. Comply with the requirements of AB 617.

Chapter 4 provides a discussion of alternatives to the proposed project as required by CEQA. According to the CEQA guidelines, alternatives should include feasible measures to attain the basic objectives of the proposed project and provide means for evaluating the comparative merits of each alternative. In addition, though the range of alternatives must be sufficient to permit a reasoned choice, they need not include every conceivable project alternative (CEQA Guidelines, §15126.6(a)). The key issue is whether the selection and discussion of alternatives fosters informed decision making and public participation.

In accordance with CEQA Guidelines §15126.6(c), a CEQA document should identify any alternatives that were considered by the lead agency, but were rejected as infeasible during the scoping process and briefly explain the reason underlying the lead agency's determination. Section 15126.6(c) also states that among the factors that may be used to eliminate alternatives from detailed consideration in an EIR are: (1) failure to meet most of the basic project objectives; (2) infeasibility; or (3) inability to avoid significant environmental impacts.

Alternatives that consider other rule development projects were rejected as infeasible because they would not be compliant or achieve the goals of AB 617. AB 617 requires air districts to review the emissions control technology installed on pollution sources located at industrial facilities subject to the Cap-and-Trade program. The schedule must give priority to any sources that have not had emissions limits modified for the greatest period of time. The schedule does not apply to sources that have implemented BARCT since 2007. No other rule development projects were identified that would comply with these requirements.

4.2 DESCRIPTION OF THE PROJECT ALTERNATIVES

The possible alternatives to the Expedited BARCT Implementation Schedule are limited by the nature of the project. Other than the No Project Alternative, the other alternative is limited to adjusting the timeline of the implementation schedule. This is because of the conditions imposed by AB 617, which define the scope and timeline of the project. Therefore, the alternatives will be limited to delaying the Expedited BARCT Implementation Schedule to its maximum extent while still complying with AB 617 (except for the No Project Alternative).

4.2.1 ALTERNATIVE 1 – NO PROJECT ALTERNATIVE

CEQA Guidelines §151216.6 (e) requires evaluation of a "No Project Alternative." Under the No Project Alternative, the Expedited BARCT Implementation Schedule would not be implemented. There would be no rule development activity for new rules or rule amendments to:

- Reduce ROG emissions from Organic Liquid Storage Tanks;
- Reduce ROG emissions associated with refinery wastewater treatment systems;
- Reduce PM and SO_2 emissions from Portland cement manufacturing;
- Reduce PM and SO_2 emissions from Refinery Fluid Catalytic Cracking Units and CO gas boilers;
- Reduce ROG emissions from fugitive heavy liquid leaks; and
- Reduce NOx emissions from petroleum coke calcining operations.

Under Alternative 1, no additional air pollution control equipment or measures (e.g., monitoring/repair of fugitive heavy liquid leaks) would be implemented. Alternative 1 would not comply with AB 617, which requires air districts to address industrial Cap-and-Trade facilities that do not have BARCT in place and adopt an Expedited BARCT Implementation Schedule. Therefore, Alternative 1 would not comply with the AB 617 requirements. Per CEQA Guidelines §15364, "feasible" "means capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, legal, social, and technological factors." Alternative 1 would not comply with the AB 617 requirements and would not be considered feasible at this time.

It should be noted that it would be unlikely that the District would remain out of compliance with AB 617 indefinitely and some action would likely be taken in the future to comply. Nonetheless, for the purpose of comparison and public disclosure, it will be assumed that no action will be taken under the No Project Alternative.

4.2.2 ALTERNATIVE 2 – BARCT DELAYED IMPLEMENTATION

AB 617 requires each air district that is in nonattainment for one or more air pollutants to adopt an expedited schedule for implementation of BARCT by the earliest feasible date, but no later than December 31, 2023. The Expedited BARCT Implementation Schedule is shown in Table 4.2-1 and shows that the applicable rules would be amended or adopted by third quarter of 2021. Alternative 2 would delay the Expedited BARCT Implementation Schedule so that all rules would not be implemented until 2023, which is the deadline for implementing monitoring and air pollution controls measures required under AB 617 (see Table 4.2-2). Therefore, the overlap of construction activities would be expected to be reduced; however, there will be a loss of operational emissions benefits (emissions reductions) for several years as compared to the proposed project.

TABLE 4.2-1

Proposed Project - Expedited BARCT Implementation Schedule

Rule Development Project	Pollutants Addressed	Anticipated Development Schedule	2018				2019				2020				2021			
Organic Liquid Storage Tanks	ROG	Q4 2018 – Q1 2020																
Petroleum Wastewater Treating	ROG	Q1 2019 – Q3 2020																
Portland Cement Manufacturing	PM, SO_2	Q2 2019 – Q2 2021																
Refinery Fluid Catalytic Crackers and CO Boilers	PM, SO_2	Q1 2019 – Q4 2020																
Refinery Heavy Liquids Leaks	ROG	Q1 2019 – Q4 2019																
Petroleum Coke Calcining	NOx	Q3 2020 – Q3 2021																

TABLE 4.2-2

Alternative 2 – Delayed BARCT Implementation Schedule

Rule Development Project	Pollutants Addressed	Anticipated Development Schedule	2018		2019		2020		2021		2022		2023	
Organic Liquid Storage Tanks	ROG	Q3 2019 – Q4 2020												
Petroleum Wastewater Treating	ROG	Q3 2020 – Q2 2022												
Portland Cement Manufacturing	PM, SO_2	Q1 2020 – Q2 2022												
Refinery Fluid Catalytic Crackers and CO Boilers	PM, SO_2	Q3 2020 – Q4 2022												
Refinery Heavy Liquids Leaks	ROG	Q3 2019 – Q2 2020												
Petroleum Coke Calcining	NOx	Q1 2023 – Q4 2023												

4.3 ENVIRONMENTAL IMPACTS OF PROJECT ALTERNATIVES

4.3.1 ALTERNATIVE 1 – NO PROJECT ALTERNATIVE

4.3.1.1 Air Quality

Under Alternative 1, the Expedited BARCT Implementation Schedule would not be implemented. Therefore, no construction emissions are expected under the No Project Alternative. As shown in Table 3.2-26, the worst-case construction schedule for the proposed project would be expected to result in ROG, NOx, PM_{10}, and $PM_{2.5}$ emissions that would exceed significance thresholds. Therefore, the Expedited BARCT Implementation Schedule would result in significant air quality impacts during construction activities, which would also be cumulatively considerable. The significant construction air quality impacts would be eliminated under Alternative 1.

The operational air quality impacts associated with the proposed project were determined to be less than significant. Impacts from the potential increase in operational emissions, including emissions from truck traffic, were determined to be less than significant. Nonetheless, they would be eliminated under Alternative 1.

The overall emission benefits that are expected from the proposed project are presented in Table 4.3-1. For some of the potential rule development projects, emission reductions may be unknown at this time but would nonetheless be expected to occur. Under Alternative 1, the beneficial impacts associated with ROG emission reductions (75 to 125 tons per year) and SOx emissions reductions (1,265 tons per year) would also not occur.

Impacts from the potential increase in TAC emissions associated with the proposed project were also determined to be less than significant. Further, the proposed project is expected to result in a beneficial reduction in TAC emissions, as well, as criteria pollutants. However, it is not possible to estimate the potential TAC emissions reductions at this point until appropriate engineering analyses have been completed and so forth. Nonetheless, air pollution control measures to control ROG emissions (e.g., domes on tanks and additional ROG monitoring on fugitive components in heavy liquid service) as a result of the proposed project is expected to result in a reduction in TAC emissions from affected facilities. The potential TAC emissions reductions under the proposed project would be eliminated under Alternative 1.

TABLE 4.3-1

Expedited BARCT Implementation Schedule Emission Reductions Associated with Rule Development Projects

Rule Development Project Title	Estimated Emission Reductions Criteria Air Pollutants (tons/yr)				
	ROG	CO	NOx	SOx	PM
Organic Liquid Storage Tanks[1]	75 - 125	--	--	--	--
Petroleum Wastewater Treating	Unknown[(2)]	--	--	--	--
Portland Cement Manufacturing	--	--	--	698	Unknown
Refinery Fluid Catalytic Crackers and CO Boilers	--	--	--	567	Unknown
Refinery Heavy Liquid Leaks	Unknown	--	--	--	--
Petroleum Coke Calcining	--	--	Unknown	--	--

(1) The Organic Liquid Storage Tanks Project, Petroleum Wastewater Treating and Refinery Heavy Liquid Leak projects will also reduce TAC emissions. TAC emissions are not readily quantifiable and are thus not presented.
(2) For some of the potential rule development projects the estimates of emissions reductions are unknown at this time. This is due to uncertainties associated with emission estimates or the level of control and emission reductions that are achievable.

4.3.1.2 Hazards and Hazardous Materials

The hazard impacts associated with the installation of air pollution control equipment under the Expedited BARCT Implementation Schedule are expected to be less than significant. Under Alternative 1, none of the potential rules or rule amendments associated with the Expedited BARCT Implementation would occur at this time and the impacts from related hazards, including transport of materials, use of hazardous materials, and hazards associated with air pollution control equipment would remain less than significant.

4.3.1.2 Hydrology and Water Quality

Water demand impacts from operating WGS systems at refinery FCCUs, additional lime injection at a cement kiln, and a LoTOx at a coke calciner may exceed applicable water demand significance thresholds and, therefore, water demand impacts associated with the proposed project were concluded to be significant after mitigation and cumulatively considerable. Under Alternative 1, no additional air pollution control equipment would be installed at this time; therefore, no significant or cumulatively considerable impacts associated with water demand would be expected.

Under the proposed project, water quality impacts from installing most types of air pollution control equipment that use water as part of the control process would not exceed applicable water quality significance thresholds and, therefore, were concluded to be less than significant. Under Alternative 1 no additional air pollution control equipment would be installed at this time; therefore, no increase in wastewater would occur and the impacts on wastewater generation and water quality would remain less than significant.

4.3.2 ALTERNATIVE 2 – DELAYED BARCT IMPLEMENTATION

4.3.2.1 Air Quality

Under Alternative 2, the Expedited BARCT Implementation Schedule would be delayed until 2023. Under Alternative 2, all of the proposed BARCT rule development projects would be implemented, but would be implemented at a slower pace. As shown in Table 3.2-26, the worst-case construction schedule for the proposed project would be expected to result in ROG, NOx, PM_{10}, and $PM_{2.5}$ emissions that would exceed the significance thresholds. Therefore, the Expedited BARCT Implementation Schedule would result in significant air quality impacts during construction activities, which would also be cumulatively considerable. The significant construction air quality impacts would be reduced under Alternative 2. As shown in Table 4.3-2, Alternative 2 would be expected to reduce the overlap in construction emissions. However, the emissions, while less than the proposed project, would still be expected to exceed the significance threshold and impacts from construction emissions would remain significant.

TABLE 4.3-2

Estimated Construction Emissions Under Alternative 2

ACTIVITY	ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$
Peak Daily Concurrent Construction Emissions (lbs/day)						
2 VRU, Incinerators, or Vapor Combustors	0.1	0.7	0.9	<0.1	0.3	0.2
2 Domes	4.9	49.6	46.8	0.2	5.2	3.1
3 Refinery WGS	51	201	252	0.3	117	69
Total Concurrent Emissions (lbs/day)	**56.0**	**251.3**	**299.7**	**0.6**	**122.5**	**72.3**
Significance Thresholds	**54**	**None**	**54**	**None**	**82**	**54**
Significant?	**Yes**	**--**	**Yes**	**--**	**Yes**	**Yes**
Proposed Project Emission Estimates	**70.5**	**347.7**	**395.2**	**1.5**	**135.6**	**81.3**

The operational air quality impacts associated with the proposed project were determined to be less than significant. Impacts from the potential increase in operational emissions, including the emissions from truck traffic, were determined to be less than significant.

The operational emissions under Alternative 2 would remain the same as the proposed project and associated impacts would also be less than significant.

The overall emission benefits that are expected from the proposed project are presented in Table 4.3-1. For some of the potential rule development projects, emission reductions may be unknown at this time but would nonetheless be expected to occur. Under Alternative 2, the beneficial impacts associated with ROG emission reductions (75 to 125 tons per year) and SOx emissions reductions (1,265 tons per year) still be expected to occur. However, those benefits could be delayed for several years. Therefore, Alternative 2 could result in emission reductions forgone (not achieved) during the two year delay period of an estimated 150 – 250 tons of ROG and up to 2,530 tons of SOx.

Impacts from the potential increase in TAC emissions associated with the proposed project were also determined to be less than significant. The proposed project is expected to result in a beneficial reduction in TAC emissions, as well, as criteria pollutants. However, it is not possible to estimate the potential TAC emissions reductions at this point until appropriate engineering analyses have been completed and so forth. Nonetheless, air pollution control equipment installed to control ROG emissions (e.g., domes on tanks and additional ROG monitoring on fugitive components in heavy liquid service) as a result of the proposed project is expected to result in a reduction in TAC emissions from affected facilities. The potential TAC emissions reductions under the proposed project are expected to be the same as the proposed project, although those reductions may be delayed for a period of approximately two years.

4.3.2.2 Hazards and Hazardous Materials

The hazard impacts associated with the installation of air pollution control equipment under the Expedited BARCT Implementation Schedule are expected to be less than significant. All of the air pollution control equipment that would installed under the proposed project would also be installed under Alternative 2. Therefore, hazard impacts under Alternative 2 would be the same as the proposed project and less than significant.

4.3.2.2 Hydrology and Water Quality

Water demand impacts from operating WGS systems at refinery FCCUs, additional lime injection at a cement kiln, and a LoTOx at a coke calciner may exceed applicable water demand significance thresholds and, therefore, water demand impacts associated with the proposed project were concluded to be significant after mitigation and cumulatively considerable. All of the air pollution control equipment that would be installed under the proposed project would also be installed under Alternative 2. Therefore, water demand impacts under Alternative 2 would remain significant.

Under the proposed project, water quality impacts from installing most types of air pollution control equipment that use water as part of the control process would not exceed applicable water quality significance thresholds and, therefore, were concluded to be less than significant. All of the air pollution control equipment that would be installed under the proposed project would also be installed under Alternative 2. Therefore, water quality impacts under Alternative 2 would be the same as the proposed project and less than significant.

4.4 CONCLUSION

Alternative 1 - No Project Alternative would theoretically reduce the potentially significant ROG, NOx, PM_{10}, and $PM_{2.5}$ construction air quality impacts and water demand impacts associated with the Expedited BARCT Implementation Schedule. However, Alternative 1 is not feasible due to legal factors, as it would violate the requirements of AB 617. Further, Alternative 1 would not achieve any of the project objectives 1 through 4 (see page 4-1).

Under Alternative 2, the BARCT Implementation Schedule would be extended with all of the proposed rule development projects implemented by 2023, instead of 2021. The impacts under Alternative 2 would essentially be the same as the proposed project, as all of the proposed rule projects included in the proposed project would also be implemented under Alternative 2. The potentially significant ROG, NOx, PM_{10}, and $PM_{2.5}$ construction air quality impacts would be reduced, but they would not be reduced to less than significant.

Under Alternative 2, the beneficial impacts associated with ROG emission reductions (75 to 125 tons per year) and SOx emissions reductions (1,265 tons per year) would still be expected to occur. However, those emission reduction benefits could be delayed for several years. Therefore, Alternative 2 could result in emission reductions forgone (not achieved) during the two year delay period of an estimated 150 – 250 tons of ROG and up to 2,530 tons of SOx.

Finally, potentially significant water demand impacts would remain as the same as the proposed project, because all of the air pollution control equipment under the proposed project, would still be implemented under Alternative 2, including the WGS and LoTOx equipment. Water demand impacts under Alternative 2 would remain significant and cumulatively considerable.

4.5 COMPARISON OF ALTERNATIVES

Pursuant to CEQA Guidelines §15126.6(d), an EIR should include sufficient information about each alternative to allow meaningful comparison with the proposed project. Section 15126.6(d) also recommends the use of a matrix to summarize the comparison. Table 4.5-1 provides this matrix comparison displaying the major characteristics and significant environmental effects of each alternative. Table 4.5-1 lists the alternatives considered in this EIR and how they compare to the proposed project. Table 4.5-1 presents a matrix that lists the significant adverse impacts as well as the cumulative impacts associated with the proposed project and the project alternatives for all environmental topics analyzed. The table also ranks each section as to whether the proposed project or a project alternative would result in greater or lesser impacts relative to one another.

TABLE 4.5-1

COMPARISON OF ALTERNATIVES

ENVIRONMENTAL TOPIC	Proposed Project	Alternative 1 No Project Alternative	Alternative 2 Delayed BARCT Implementation Schedule
Air Quality			
Construction Emission Impacts	PS	NS (-)	PS (-)
Operational Criteria Pollutant Impacts	NS	NS (-)	NS (=)
Toxic Air Contaminant Impacts	NS	NS (-)	NS (=)
Cumulative Air Quality Impacts	PS	NS (-)	PS (-)
Hazards and Hazardous Materials			
Operational Hazard Impacts	NS	NS (-)	NS (=)
Transportation Hazard Impacts	NS	NS (-)	NS (=)
Cumulative Hazards Impacts	NS	NS (-)	NS (=)
Hydrology and Water Quality			
Construction Water Demand Impacts	NS	NS (-)	NS (=)
Operational Water Demand Impacts	PS	NS (-)	PS (=)
Wastewater/Water Quality Impacts	NS	NS (-)	NS (=)
Cumulative Hydrology/Water Quality Impacts	PS	NS (-)	PS (=)

Notes:
PS = Potentially significant
MNS = Mitigated to less than significant
NS = Less than significant
(-) = Potential impacts are less than the proposed project.
(+) = Potential impacts are greater than the proposed project.
(=) = Potential impacts are approximately the same as the proposed project.

As shown in Table 4.5-1, Alternative 1 would eliminate the potentially significant ROG, NOx, PM_{10}, and $PM_{2.5}$ impacts associated with construction activities but would not achieve any of the proposed project objectives. Alternative 1 could be considered the environmentally superior alternative. Alternative 2 would reduce the potentially significant ROG, NOx, PM_{10}, and $PM_{2.5}$ impacts associated with construction activities, but not to less than significant levels, and the water demand impact would be the same as the proposed project; however, Alternative 2 would achieve all of the project objectives. Since Alternative 2 would reduce the potentially significant ROG, NOx, PM_{10}, and $PM_{2.5}$ impacts and achieve the project objectives, Alternative 2 would be considered the environmentally superior alternative.

The proposed project would be considered the preferred alternative as it would achieve all of the project objectives and emission reductions associated with the implementation of BARCT on the affected facilities would be expected to occur two years earlier than under Alternative 2.

The proposed project has been demonstrated to be the most effective approach that achieves all of the project objectives relative to environmental impacts generated. Mitigation measures have been developed to minimize the potential increase in construction emissions and water demand, while providing the greatest public health benefit by reducing criteria pollutant emissions from stationary sources to the greatest feasible extent. Further, emission reductions associated with the implementation of BARCT on the affected facilities would be expected to occur two years earlier than under Alternative 2. Therefore, the proposed project is the preferred alternative.

CHAPTER 5

REFERENCES

References
Organizations and Persons Consulted
List of Environmental Impact Report Preparers

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5.2 ORGANIZATIONS AND PERSONS CONSULTED

The CEQA statues and Guidelines require that organizations and persons consulted be provided in the EIR. The following organizations and persons have provided input into this document.

Victor Douglas
Todd Gonsalves
Guy Gimlen
David Joe

5.3 LIST OF ENVIRONMENTAL IMPACT REPORT PREPARERS

Bay Area Air Quality Management District
San Francisco, California

Environmental Audit, Inc.
Placentia, California

APPENDIX A

NOTICE OF PREPARATION AND INITIAL STUDY

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California Environmental Quality Act

Notice of Preparation of Draft Environmental Impact Report and Scoping Meeting for AB 617 Expedited Best Available Retrofit Control Technology Implementation Schedule

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TO: **Interested Parties**

FROM: **Bay Area Air Quality Management District**
375 Beale St., Suite 600
San Francisco, CA 94105

Lead Agency: Bay Area Air Quality Management District
Contact: Victor Douglas, Manager Phone: (415) 749-4752

SUBJECT: NOTICE OF PREPARATION OF A DRAFT ENVIRONMENTAL IMPACT REPORT AND SCOPING MEETING

Notice is hereby given pursuant to California Public Resources Code §21091, 21092, 21092.2, and 21092.3 and CEQA Guidelines Section 15085 and 15087 that the Bay Area Air Quality Management District ("Air District"), as lead agency, will prepare a Draft Environmental Impact Report (EIR) in connection with the project described below.

Project Title: AB 617 Expedited Best Available Retrofit Control Technology (BARCT) Implementation Schedule

Project Location: The project would apply within the Bay Area Air Quality Management District ("Air District"), which includes all of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, and Santa Clara counties, and the southern portions of Solano and Sonoma counties.

Project Description: The AB 617 Expedited Best Available Retrofit Control Technology (BARCT) Implementation Schedule is intended to satisfy the requirements of Assembly Bill 617 (AB 617), which requires each air district that is a nonattainment area for one or more air pollutants to adopt an expedited schedule for implementation of best available retrofit control technology at industrial sources subject to California Greenhouse Gas (GHG) Cap-and-Trade requirements. The overall purpose of BARCT implementation is to reduce criteria pollutant emissions from these industrial sources. The project identifies six potential rule development projects to reduce air pollution from a variety of industrial stationary sources located throughout the San Francisco Bay Area Air Basin. The potential rule development projects include rules for organic liquid storage tanks, petroleum wastewater treating, Portland cement manufacturing, refinery fluid catalytic crackers and CO boilers, refinery heavy liquid leaks, and petroleum coke calcining.

Scoping Meetings: Notice is also given pursuant to California Public Resource Code, Sections 15206 and 15082 (c) that the Air District will conduct a California Environmental Quality Act (CEQA) scoping meeting at the Air District Headquarters' Yerba Buena Room, 375 Beale Street, San Francisco, California, on August 24, 2018 at 2 p.m., to discuss and accept oral comments on the scope and content described in a Notice of Preparation and an Initial Study (NOP/IS) prepared in anticipation of a draft Environmental Impact Report (DEIR) for the project.

Reviewing the Notice of Preparation/Initial Study (NOP/IS): The NOP/IS documents are available at the District headquarters, on the Air District's website at www.baaqmd.gov/ab617barct, or by request. Requests for copies of the NOP/IS should be directed to David Joe (djoe@baaqmd.gov) at (415) 749-8623.

Comment Procedure: Comments relating to the environmental analysis in the NOP/IS should be addressed to David Joe, Bay Area Air Quality Management District, 375 Beale Street, Suite 600, San Francisco, CA 94105. Comments may also be sent by e-mail to djoe@baaqmd.gov. Comments on the NOP/IS will be accepted until September 7, 2018 at 5:00 p.m.

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

Initial Study for

AB617 Expedited BARCT Implementation Schedule

Prepared by:

Bay Area Air Quality Management District
375 Beale St., Suite 600
San Francisco, CA 94109

Contact: Guy Gimlen
(415) 749-4734

August 2018

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CHAPTER 1

PROJECT DESCRIPTION

1.0 PROJECT DESCRIPTION

1.1 INTRODUCTION

The Bay Area Air Quality Management District (District or Air District), in accordance with Assembly Bill 617, (AB 617) is preparing the best available retrofit control technology (BARCT) implementation schedule project (project or proposed project). AB 617 requires each air district that is a nonattainment area for one or more air pollutants to adopt an expedited schedule for implementation of best available retrofit control technology (BARCT) by the earliest feasible date. This requirement applies to each industrial source subject to California Greenhouse Gas (GHG) Cap-and-Trade requirements.

The purpose of the proposed project is to reduce criteria pollutant emissions from industrial sources that participate in the GHG Cap-and-Trade system. The Cap-and-Trade system is designed to address and limit GHG emissions, and allows sources to comply with Cap-and-Trade limits by either reducing emissions at the source or purchasing GHG emission allowances. Emissions of criteria pollutants and toxic air contaminants are often associated with GHG emissions, and these criteria pollutants and toxic air contaminants may impact local communities that are already suffering a disproportionate burden from air pollution.

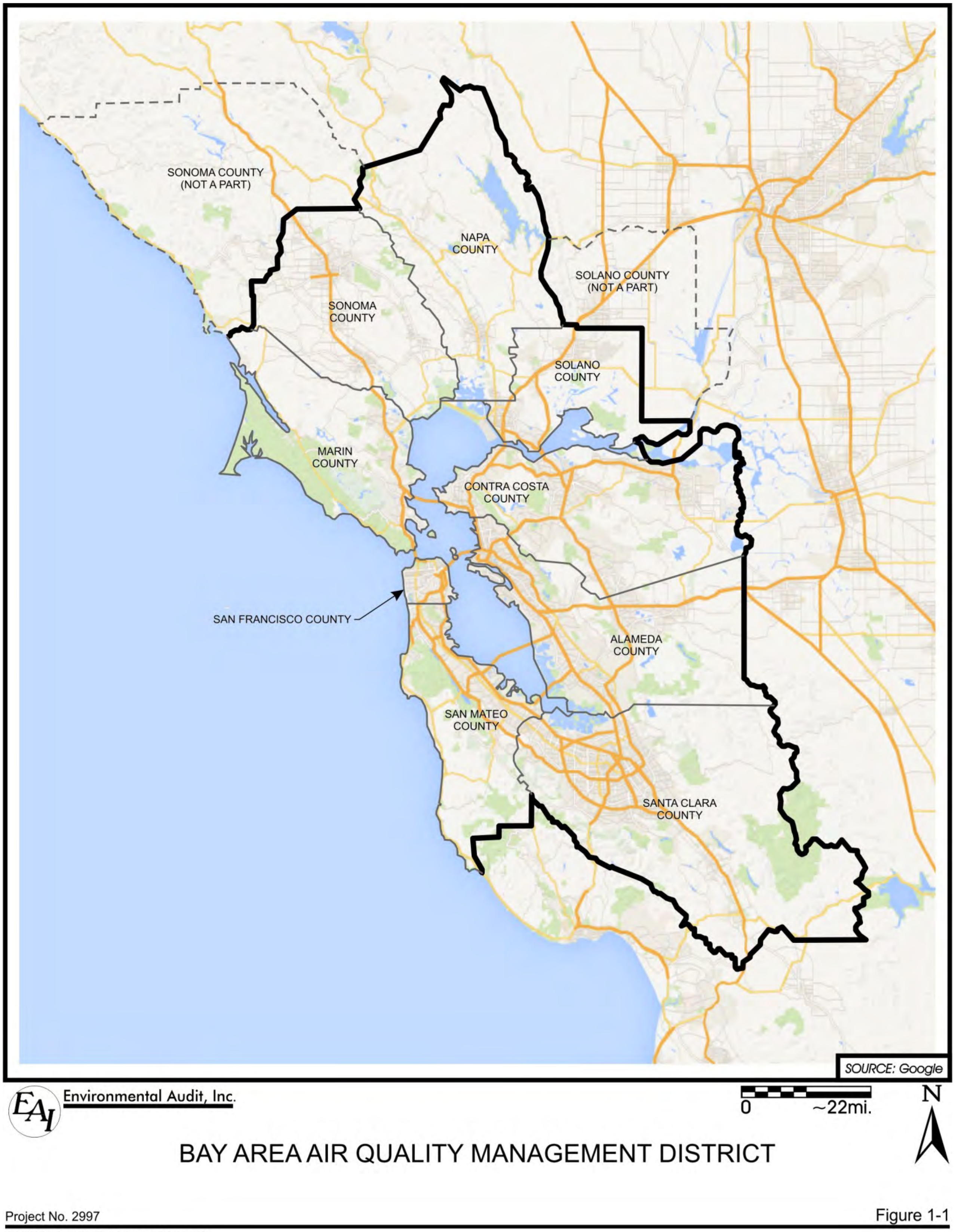
1.2 AGENCY AUTHORITY

CEQA, Public Resources Code §21000 et seq., requires that the environmental impacts of proposed projects be evaluated and that feasible methods to reduce, avoid or eliminate significant adverse impacts of these projects be identified and implemented. To fulfill the purpose and intent of CEQA, the Air District is the lead agency for this project and has prepared the Notice of Preparation/Initial Study for the proposed expedited BARCT implementation schedule.

The Lead Agency is the "public agency that has the principal responsibility for carrying out or approving a project that may have a significant effect upon the environment" (Public Resources Code Section 21067). It was determined that the Air District has the primary responsibility for supervising or approving the entire project as a whole and is the most appropriate public agency to act as lead agency (CEQA Guidelines Section 15051(b)).

1.3 PROJECT LOCATION

The Air District has jurisdiction of an area encompassing 5,600 square miles. The Air District includes all of Alameda, Contra Costa, Marin, San Francisco, San Mateo, Santa Clara, and Napa Counties, and portions of southwestern Solano and southern Sonoma counties. The San Francisco Bay Area is characterized by a large, shallow basin surrounded by coastal mountain ranges tapering into sheltered inland valleys. The combined climatic and topographic factors result in increased potential for the accumulation of air pollutants in the inland valleys and reduced potential for buildup of air pollutants along the coast. The Basin is bounded by the Pacific Ocean to the west and includes complex terrain consisting of coastal mountain ranges, inland valleys and bays (see Figure 1-1).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1.4 PROJECT BACKGROUND

With the adoption of AB 617, the state acknowledges that many communities around the state continue to experience disproportionate impacts from air pollution. To address these impacts, AB 617 directs all air districts to apply BARCT to all industrial sources subject to Cap-and-Trade, and to identify communities with a "high cumulative exposure burden" to air pollution. Districts must then prioritize these communities for the development of community air monitoring projects and/or emission reduction programs. The State requires that monitoring campaigns and emission reduction programs be developed through a community-based process.

AB 617 represents a significant enhancement to the approach CARB and local air districts take in addressing local air quality issues. The Air District has already implemented and established a number of programs that support the goals and intent of AB 617; these programs include the Community Air Risk Evaluation (CARE) Program, Health Risk Assessments for the AB 2588 Air Toxics "Hot Spots" Program, and Air District Rule 11-18: Reduction of Risk from Air Toxic Emissions at Existing Facilities. However, the requirements of AB 617 formalize new programs and establish challenging goals and timelines for implementation.

The purpose of the proposed project is to reduce criteria pollutant emissions from industrial sources that participate in the GHG Cap-and-Trade system. The Cap-and-Trade system is designed to address and limit GHG emissions, and allows sources to comply with Cap-and-Trade limits by either reducing emissions at the source or purchasing GHG emission allowances. The Cap-and-Trade program includes particular provisions for "industrial" facilities, which are covered entities or facilities that are eligible for free allowance allocation. Under the Cap-and-Trade program, these free allocations are provided to certain industrial sectors to minimize potential leakage of economic activity and GHG emissions. Emissions of criteria pollutants and toxic air contaminants are often associated with GHG emissions, and these criteria pollutants and toxic air contaminants may impact local communities that are already suffering a disproportionate burden from air pollution. The proposed project aims to implement rule development projects that will require the use of BARCT for specific equipment in industrial facilities that are subject to GHG Cap-and-Trade requirements in order to reduce criteria pollutant emissions.

1.5 PROJECT DESCRIPTION

The expedited BARCT Implementation Schedule strategy will consist of the implementation of several rule development projects in order to fulfill the requirements of AB 617. The Bay Area air basin is in attainment with both the National Ambient Air Quality Standards and California Ambient Air Quality Standards for carbon monoxide (CO), SO_2, NO_2, and Lead. The air basin is designated as nonattainment for ozone (O_3) and particulate matter ($PM_{2.5}$ and PM_{10}) California ambient air standards, therefore the BARCT review was conducted focusing on the following pollutants:

- Nitrogen Oxides (NOx)
- Reactive Organic Gases (ROG)
- Particulate Matter less than 10 microns (PM_{10})
- Particulate Matter less than 2.5 microns ($PM_{2.5}$)
- Sulfur Dioxide (SO_2)

NOx and ROG are included because they are precursors for ozone formation. SO_2 may contribute to the formation of condensable PM (i.e. formed in the emissions plume from the stack) at certain types of sources, so PM control strategies may include SO_2 limits.

A list of facilities, sources, and emissions were developed from the 2016 Reporting Year Emissions Inventory. The Bay Area has 80 facilities subject to Cap-and-Trade, which encompass 3,246 individual sources in 61 source categories. This list of facilities was reduced to 19 "industrial" facilities, which includes all covered entities that are eligible for free allowance allocations in accordance with the Cap-and-Trade requirements based on their engagement in an activity within a particular North American Industrial Code System (NAICS) Code listed in Table 8-1 of the Cap-and-Trade regulation (17 CCR § 95890(a)). These 19 industrial Cap-and-Trade facilities encompass 1,899 individual sources in 50 source categories. These sources were reviewed, and screening was conducted to remove sources where potential emission reductions would likely be small and not cost-effective (e.g., less than 10 pounds per day) and sources that already comply with BARCT. After screening for these sources with emissions greater than 10 pounds per day and sources that do not already achieve BARCT, the population of sources was reduced to the following (percentage values represent the percentage of total emissions from initial population of industrial Cap-and-Trade sources in the Bay Area):

- NOx: 21 source categories, 73 sources representing 30% of the emissions (1,764 tpy)
- ROG: 23 source categories, 259 sources representing 93% of the emissions (4,430 tpy)
- PM: 16 source categories, 124 sources representing 92% of the emissions (2,358 tpy)
- SO_2: 15 source categories, 102 sources representing 71% of the emissions (3,651 tpy)

The Air District reviewed available information on current achievable emission limits and potential controls for each source category and pollutant. This information included guidelines and recent determinations of BACT, reasonably available control technology (RACT), and lowest achievable emission rate (LAER) from EPA and CARB. Six potential priority rule development projects have been identified as candidates for the expedited BARCT Implementation Schedule Project. Potential priority rule development projects are shown in Table 1-1.

1.6 SOURCES THAT MAY BE SUBJECT TO THE EXPEDITED BARCT SCHEDULE

The overall purpose of the expedited BARCT implementation schedule is to reduce criteria pollutant emissions from industrial sources that participate in CARB's GHG Cap-And-Trade program. Emissions of criteria pollutants and toxic air contaminants are often associated with GHG emissions, and these criteria pollutants and toxic air contaminants may impact local communities. The expedited BARCT implementation schedule would apply to a wide range of commercial, industrial, and municipal facilities including petroleum refineries, chemical plants, wastewater treatment facilities, and manufacturing operations. Table 1-2 shows the most likely types of facilities anticipated to be subject to the expedited BARCT implementation schedule and the primary emissions that would be controlled.

TABLE 1-1 – Expedited BARCT Schedule Priority Rule Development Projects

PROPOSED RULE DEVLOPMENT PROJECTS – BARCT IMPLEMENTATION PLAN		
Project Name	**Pollutant**	**Rule Development Project Summary**
Organic Liquid Storage Tanks	ROG	Regulation 8, Rule 5: Storage of Organic Liquids would be amended to specifically address ROGs and associated TACs emissions from external floating roof tanks storing organic liquids. Emission reductions are expected from installing domes on external floating roof tanks and capturing emissions from internal floating roof tanks or coned roof tanks and removing ROG emissions through a vapor recovery unit to a thermal incinerator.
Petroleum Wastewater Treating	ROG	The Air District has addressed ROG emissions from petroleum wastewater treatment facilities (Rule 8-8 Wastewater Collection and Separation Systems) in previous rule developments. This project will review each of the five Bay Area refineries for any opportunities for reduction of wastewater ROG emissions. BACT for refinery wastewater systems includes the use of entirely enclosed systems in addition to good control practices.
Portland Cement Manufacturing	PM SO_2	BARCT levels are still under development for PM emissions in cement kilns; however, controls will likely involve the reduction of SO_2, ammonia, or other condensable components and precursors. BARCT for SO_2 emissions reductions includes the judicious selection and use of raw materials, dry scrubbing, and dry sorbent (lime) injection.
Refinery Fluid Catalytic Crackers and CO Boilers	PM SO_2	PM and SO_2 emissions reductions are expected through optimization of ammonia injection, additional ESP capacity, optimization of newer catalyst additives, and/or wet gas scrubbing.
Refinery Heavy Liquid Leaks	ROG	Amendments to Regulation 8, Rule 18: Equipment Leaks (Rule 8-18) in December 2015 addressed equipment that service heavy liquids at these sources, but those amendments have not yet been fully implemented due to litigation regarding uncertainty of heavy liquid fugitive emissions. The District is coordinating with each of the five Bay Area refineries to conduct Heavy Liquid Leak Studies. These studies are designed to determine appropriate emission factors for heavy liquid leaks. The results of these studies are expected by Fall 2018. BARCT levels will likely be set after these studies have concluded; implementation is expected to involve additional leak detection and repair (LDAR) provisions for components in heavy liquid service.
Petroleum Coke Calcining	NOx	Regulation 9, Rule 14: Petroleum Coke Calcining Operations (Rule 9-14), which currently only addresses SO_2 emissions, may be amended to include NOx emission limits. Technologies available for NOx reduction in petroleum coke calcining operations is expected to include SCRs and LoTOx injection systems.

TABLE 1-2

Summary of Facilities and Sources Where BARCT Priority Rule Projects May Apply Under the Expedited BARCT Schedule Requirements

Facility	Sources	Pollutants Controlled
Refineries	Fugitive Emissions (tanks, valves, pumps, compressors) Fluidized Catalytic Cracking Units CO Boilers Wastewater Treatment Operations	ROG PM SO_2
Petroleum Coke Calcining	Coke Calciners	NOx
Cement Manufacturing	Cement Kiln	PM SO_2
Refineries, Chemical Plants, Bulk Storage and Transfer Operations, and General Manufacturing	Organic Liquid Storage Tanks	ROG

1.6.1 REFINERIES

Petroleum refineries convert crude oil into a wide variety of refined products, including gasoline, aviation fuel, diesel and other fuel oils, lubricating oils, and feed stocks for the petrochemical industry. Crude oil consists of a complex mixture of hydrocarbon compounds with smaller amounts of impurities including sulfur, nitrogen, oxygen and metals (e.g., iron, copper, nickel, and vanadium). Crude oil that originates from different geographical locations may vary with respect to its composition, thus, potentially generating different types and amounts of emissions. The types of equipment where BARCT may be applied under the expedited BARCT requirements are further described below.

Fugitive Emissions Sources: Petroleum refineries include a large number and wide variety of fugitive emissions sources. Fugitive emissions are emissions of gases or vapors from pressurized equipment due to leaks and other unintended or irregular releases of gases during the crude refining process and do not include pollutants vented to an exhaust stack before release to the atmosphere. Generally, any processes or transfer areas where leaks can occur are sources of fugitive emissions. Fugitive emissions sources include, but are not limited to the following: valves, connectors (i.e., flanged, screwed, welded or other joined fittings), pumps, compressors, pressure relief devices, and diaphragms in ROG service. Fugitive emissions are generally controlled through leak detection and repair (LDAR) programs. Similarly, tanks storing crude oil or petroleum products also produce fugitive emissions.

Fluid Catalytic Cracking Units (FCCUs) and CO Boilers: FCCUs are complex processing units that convert heavy components of crude oil into light, high-octane products that are required in the production of gasoline. Each FCCU consists of a reaction chamber, a catalyst regenerator, and a fractionator. The cracking process begins in the reaction chamber were fresh catalyst is mixed with pre-heated heavy oils. A chemical reaction occurs that converts the heavy oil into a cracked hydrocarbon vapor mixed with catalyst. As the cracking reaction progresses, the cracked hydrocarbon vapor is routed to a distillation column or fractionator for further separation into lighter hydrocarbon components such as light gases, gasoline, light gas oil, and cycle oil. The catalyst becomes coated with carbonaceous material (coke) during its exposure to the hydrocarbon feedstock. FCCUs include a catalyst regenerator where coke is burned off the surface of the catalyst to restore its activity so it can be re-used. Catalyst regenerators may be designed to burn the coke completely to carbon dioxide (full burn) or to only partially burn the coke to a mixture of CO and CO_2 (partial burn). Because the flue gas from these partial burn regenerators has high levels of CO, the flue gas is vented to a CO boiler where the CO is further combusted to CO_2. FCCUs and associated CO boilers can generate substantial PM, NOx, and SO_2 emissions.

Petroleum Wastewater Treating: All refineries employ some form of wastewater treatment so that water effluents can safely be reused at the refinery or discharged. Wastewater treatment operations provide a means of treating water that has come into contact with petroleum hydrocarbons, and, as such, are a potential source of ROG emissions. The design of wastewater treatment plants is complicated by the diversity of refinery pollutants, including oil, phenols, sulfides, dissolved solids, and toxic chemicals. Although the treatment processes employed by refineries vary greatly they generally include drain systems, neutralizers, oil/water separators, settling chambers, clarifiers, dissolved air flotation systems, coagulators, and activated sludge units.

Drain systems consist of individual process drains, where oily water from various sources is collected, and junction boxes, which receive the oily water from multiple drains. The first stage of a typical wastewater treatment process is the oil-water separator, which physically separates the free oil and solids from the water. Gravity allows any oil in the water to rise to the surface of the separator and any solid particles to sink to the bottom. A continually moving scraper system pushes oil to one end and the solids to the other. Both are removed and the recovered oil is sent back to the refinery for reprocessing. Small suspended oil particles are then typically removed in the dissolved air flotation unit. Wastewater is sent to the activated sludge units, where naturally-occurring microorganisms feed on the dissolved organics in the wastewater, and convert them to water, CO_2 and nitrogen gas, which can be safely released into the atmosphere. Finally, wastewater enters the clarifying tanks, where the microorganisms settle to the bottom while the treated wastewater flows away.

1.6.2 PETROLEUM COKE CALCINING

Petroleum coke, the heaviest portion of crude oil, cannot be recovered in the normal refining process. Instead, petroleum coke is processed in a delayed coker unit to generate a carbonaceous solid referred to as “green coke,” a commodity. To improve the quality of the product, if the green coke has a low metals content, it will be sent to a calciner to make calcined petroleum coke. Calcined petroleum coke can be used to make anodes for the aluminum, steel, and titanium smelting industry. If the green coke has a high metals content, it can be used as a fuel grade coke by the fuel, cement, steel, calciner and specialty chemicals industries.

The process of making calcined (removing impurities) petroleum coke begins when the green coke feed from the delayed coker unit is screened and transported to the calciner unit where it is stored in a covered coke storage barn. The screened and dried green coke is introduced into the top end of a rotary kiln and is tumbled by rotation under high temperatures that range between 2,000 and 2,500 degrees Fahrenheit (^oF). The rotary kiln relies on gravity to move coke through the kiln countercurrent to a hot stream of combustion air produced by the combustion of natural gas or fuel oil. As the green coke flows to the bottom of the kiln, it rests in the kiln for approximately one additional hour to eliminate any remaining moisture, impurities, and hydrocarbons. Hot gases from the calciner are sent to a pyroscrubber that removes particulates through a combination of settling and incineration and sulfur compounds are oxidized to SO_2. Once discharged from the kiln, the calcined coke is dropped into a cooling chamber, where it is quenched with water, treated with de-dusting agents to minimize dust, and carried by conveyors to storage tanks and sold for industrial uses.

1.6.3 CEMENT MANUFACTURING

Cement is manufactured in a cement kiln using a pyroprocess or high temperature reactor that is constructed along a longitudinal axis with segmented rotating cylinders whose connected length is anywhere from 50 to 200 yards in length. The pyroprocess in the kiln consists of three phases during which clinker is produced from raw materials undergoing physical changes and chemical reactions. The first phase in the kiln, the drying and pre-heating zone, operates at a temperature between 1,000 ^{o}F and 1,600 ^{o}F and evaporates any remaining water in the raw mix of materials entering the kiln. The second phase, the calcining zone, operates at a temperature between 1,600 ^{o}F and 1,800 ^{o}F and converts the calcium carbonate from the limestone in the kiln feed into calcium oxide and releases CO_2. During the third phase, the burning zone operates on average at 2,200 ^{o}F to 2,700 ^{o}F (though the flame temperature can at times exceed 3,400 ^{o}F) during which several reactions and side reactions occur. As the materials move towards the discharge end, the temperature drops and eventually clinker nodules form and volatile constituents, such as sodium, potassium, chlorides, and sulfates, evaporate. The red-hot clinker exits the kiln, is cooled in the clinker cooler, passes through a crusher and is conveyed to storage.

As indicated above, cement manufacturing occurs at high temperatures and uses several combustion fuels. Fuels that have been used for primary firing include coal, petroleum coke, heavy fuel oil, natural gas, landfill off-gas and oil refinery flare gas. High carbon fuels such as coal are preferred for kiln firing, because they yield a luminous flame. The clinker is brought to its peak temperature mainly by radiant heat transfer, and a bright (i.e. high emissivity) and hot flame is essential for this. Combustion emissions are exhausted through the kiln's stack.

At cement manufacturing facilities, fugitive dust may consist of wind-driven particulate matter emissions from any disturbed surface work area that are generated by wind action alone. The process of making cement begins with the acquisition of raw materials, predominantly limestone rock (calcium carbonate) and clay, which exist naturally in rocks and sediment on the earth's surface. These and other materials used to manufacture cement are typically mined at nearby quarries and comprise "raw mix." The raw mix is refined by a series of mechanical crushing and grinding operations to segregate and eventually reduce the size of each component to 0.75 inch or smaller before being conveyed to storage.

1.6.4 ORGANIC LIQUID STORAGE FACILITIES

Storage vessels containing organic liquids can be found in many industries, including: (1) petroleum producing and refining; (2) petrochemical and chemical manufacturing; (3) bulk storage and transfer operations; and (4) other industries consuming or producing organic liquids. Organic liquids in the petroleum industry generally are mixtures of hydrocarbons having dissimilar true vapor pressures (for example, gasoline and crude oil). Organic liquids in the chemical industry are composed of pure chemicals or mixtures of chemical with similar vapor pressures (for example, benzene or a mixture of isopropyl and butyl alcohols). Tanks associated with refineries comprise over 95 percent of the organic liquid storage tanks identified in the BARCT evaluation process.

Six basic tank designs are used for organic liquid storage vessels: fixed roof (vertical and horizontal), external floating roof, domed external (or covered) floating roof, internal floating roof, variable vapor space, and pressure tanks (low and high). ROG emissions from organic liquids in storage occur because of evaporative loss of the liquid during its storage and changes in the liquid level. ROG emissions vary with tank design, as does the relative contribution of each type of evaporative loss. Emissions from fixed roof tanks are a result of evaporative losses during storage (breathing losses or standing storage losses) and evaporative losses during filling and emptying operations (referred to as working losses). External and internal floating roof tanks are ROG emission sources because of evaporative losses that occur during standing storage and withdrawal of liquid from the tank. Standing storage losses are a result of evaporative losses through rim seams, deck fittings, and/or deck seams. Pressure tank losses occur when connecting to or disconnecting from the tank.

1.7 BARCT EMISSION CONTROL TECHNOLOGIES

The expedited implementation of BARCT would apply to existing facilities in the Bay Area that are generally large sources of emissions and included in the CARB GHG Cap-and-Trade program as industrial facilities. The overall purpose of the BARCT implementation schedule project is to reduce criteria pollutant emissions from industrial sources that participate in the GHG Cap-and-Trade program. Emissions of criteria pollutants and TACs are often associated with GHG emission sources.

To comply with the BARCT requirements, operators at affected facilities may need to implement different types of air pollution control equipment or measures. The type of emission capture and control technology that may be used depends on the specific source and type of pollutant to be controlled. The most common air pollution control measures that are likely to be implemented as a result of the proposed expedited BARCT schedule are categorized into the following groups and are summarized in Table 1-3:

- Installing domes on external floating roof tanks and capturing vented emissions from internal floating roof tanks or coned roof tanks and removing ROG emissions through a vapor recovery unit;
- Covering lift stations, manholes, junction boxes, conveyances and other wastewater facilities at refineries and venting ROG emissions to a vapor combustor;
- Requiring additional lime injection on cement kilns to reduce SO_2 emissions;
- Controlling PM emissions from FCCUs using SO_2 reducing catalyst additives, additional ESP capacity, or wet gas scrubbers;
- Reducing ROG emissions from fugitive components in heavy liquid service at refineries through increased LDAR programs;
- Reducing NOx emissions from coke calcining facilities through the use of SCR units and/or LoTOx system with a wet gas scrubber.

TABLE 1-3

Control Strategies and Target Pollutants

Control Strategy	Pollutant
Additional Controls on Organic Liquid Storage Tanks	ROG
Enclosures and Vapor Combustors at Refinery Wastewater Treatment Plants	ROG
Additional Lime Injection at Cement Plants	PM and SO_2
Wet Gas Scrubbers, Additional ESP Capacity, and SO_2 Reducing Catalysts at Refinery FCCUs and CO Boilers	PM and SO_2
Increase LDAR for Equipment in Heavy Liquid Service Refineries	ROG
SCR and LoTOx (wet scrubber) at Petroleum Coke Calciners	NOx

The following subsections briefly describe the most likely types of control technologies that would be used to comply with the BARCT rules included in the expedited BARCT implementation schedule.

1.7.1 ADDITIONAL CONTROLS ON ORGANIC LIQUID STORAGE TANKS

ROG emissions from organic liquids in storage occur because of evaporative loss of the liquid during its storage and as a result of changes in the liquid level. ROG emissions vary with tank design, as does the relative contribution of each type of evaporative loss.

Potential ROG emission reductions would be achieved by installing domes on external floating roof tanks and capturing vented emissions from internal floating roof tanks or coned roof tanks and removing ROG emissions through a vapor recovery unit (VRU) flowing back to the tank for recovery or VRU to a thermal incinerator. Thermal oxidizers, or thermal incinerators, are combustion devices that control volatile TAC emissions by combusting them to CO_2 and water. Domed roofs on external floating roofs without VRUs would reduce ROG emissions by limiting wind effects.

1.7.2 ENCLOSURES AND VAPOR COMBUSTORS AT REFINERY WASTEWATER TREATMENT PLANTS

The main component of atmospheric emissions from refinery wastewater treatment plants are fugitive ROG emissions and dissolved gases that evaporate from the surfaces of wastewater residing in open process drains, separators, and ponds. The control of wastewater treatment plant emissions involves covering systems where emission generation is greatest (such as oil/water separators and settling basins) and removing dissolved gases from water streams with sour water strippers before contact with the atmosphere. Covering wastewater operations potentially can achieve greater than 90 percent reduction of wastewater system emissions. In addition, all lift stations, manholes, junction boxes, conveyances and any other wastewater facilities should be covered and all emissions routed to a vapor combustor with a destruction removal efficiency (DRE) of 99 percent for control. Vapor combustors are combustion devices that control ROG emissions by combusting them to carbon dioxide and water.

1.7.3 LIME INJECTION AT CEMENT PLANTS

The formation of SO_2 in cement kilns is a product of the chemical composition of the raw materials and fuel, as well as the high operating temperatures and oxygen concentration in the kiln. In a lime injection system, a hydrated lime powder is injected into the flue gas to capture acidic gases. The cement kiln within the District’s jurisdiction currently operates a lime injection system for the control of hydrogen chloride (HCl) emissions, but the use of additional lime or additional lime injection capacity would likely be needed to further control SO_2 emissions. SO_2 reacts with lime (calcium carbonate) and is captured in the baghouse as calcium sulfate. The hydrated lime usually absorbs up to 60% of the SO_2 in the gases if injected at the correct temperature.

1.7.4 WET GAS SCRUBBERS

In wet scrubbing processes, liquid or solid particles are removed from a gas stream by transferring them to a liquid. This addresses only wet scrubbers for control of particulate matter. The liquid most commonly used is water. A wet scrubber's particulate collection efficiency is directly related to the amount of energy expended in contacting the gas stream with the scrubber liquid. Most wet scrubbing systems operate with particulate collection efficiencies over 95 percent (U.S. EPA, 2017).

There are three energy usage levels for wet scrubbers. A low energy wet scrubber is capable of efficiently removing particles greater than about 5-10 micrometers in diameter. A medium energy scrubber is capable of removing micrometer-sized particles, but is not very efficient on sub-micrometer particles. A high-energy scrubber is able to remove sub-micrometer particles.

A spray tower scrubber is a low energy scrubber and is the simplest wet scrubber used for particulate control. It consists of an open vessel with one or more sets of spray nozzles to distribute the scrubbing liquid. Typically, the gas stream enters at the bottom and passes upward through the sprays. The particles are collected when they impact the droplets. This is referred to as counter-current operation. Spray towers can also be operated in a cross-current arrangement. In cross-current scrubbers, the gas flow is horizontal and the liquid sprays flow downward. Cross-current spray towers are not usually as efficient as counter-current units.

The most common high energy wet scrubber is the venturi, although it can also be operated as a medium energy scrubber. In a fixed-throat venturi, the gas stream enters a converging section where it is accelerated toward the throat section. In the throat section, the high-velocity gas stream strikes liquid streams that are injected at right angles to the gas flow, shattering the liquid into small drops. The particles are collected when they impact the slower moving drops. Following the throat section, the gas stream passes through a diverging section that reduces the velocity.

All wet scrubber designs incorporate mist eliminators or entrainment separators to remove entrained droplets. The process of contacting the gas and liquid streams results in entrained droplets, which contain the contaminants or particulate matter. The most common mist eliminators are chevrons, mesh pads, and cyclones. Chevrons are simply zig-zag baffles that cause the gas stream to turn several times as it passes through the mist eliminator. The liquid droplets are collected on the blades of the chevron and drain back into the scrubber. Mesh pads are made from interlaced fibers that serve as the collection area. A cyclone is typically used for the small droplets generated in a venturi scrubber. The gas stream exiting the venturi enters the bottom of a vertical cylinder tangentially. The droplets are removed by centrifugal force as the gas stream spirals upward to the outlet.

1.7.5 ELECTROSTATIC PRECIPITATOR

An ESP is a control device designed to remove particulate matter (both PM_{10} and $PM_{2.5}$) from an exhaust gas stream. ESPs take advantage of the electrical principle that opposites attract. By imparting a high voltage charge to the particles, a high voltage direct current (DC) electrode negatively charges airborne particles in the exhaust stream, while simultaneously ionizing the carrier gas, producing an electrified field. The electric field in an ESP is the result of three contributing factors: the electrostatic component resulting from the application of a voltage in a dual electrode system, the component resulting from the space charge from the ions and free electrons, and the component resulting from the charged particulate. As the exhaust gas passes through this electrified field, the particles are charged. The strength or magnitude of the electric field is an indication of the effectiveness of an ESP. Typically, 20,000 to 70,000 volts are used. The particles, either negatively or positively charged, are attracted to the ESP collecting electrode of the opposite charge. When enough particulates have accumulated, the collectors are shaken to dislodge the dust, causing it to fall by gravity to hoppers below and then removed by a conveyor system for disposal or recycling. ESPs can handle large volumes of exhaust gases and because no filters are used, ESPs can handle hot gases from 350 ^{o}F to 1,300 ^{o}F.

1.7.6 SO_2 REDUCING CATALYSTS

To help reduce formation of condensable particulate matter from sulfurous components, SOx-reducing additives (catalysts) are used for reducing the production of SOx by-products in FCCUs. A SOx reducing catalyst is a metal oxide compound such as aluminum oxide (Al_2O_3), magnesium oxide (MgO), vanadium pentoxide (V_2O_5) or a combination of the three that is added to the FCCU catalyst as it circulates throughout the reactor. In the regenerator of the FCCU, sulfur-bearing coke is burned and SO_2, CO, and CO_2 by-products are formed. A portion of SO_2 will react with excess oxygen and form SO_3, which will either stay in the flue gas or react with the metal oxide in the SOx-reducing catalyst to form metal sulfate. In the FCCU reactor, the metal sulfate will react with hydrogen to form either metal sulfide and water, or more metal oxide. In the steam stripper section of the FCCU reactor, metal sulfide reacts with steam to form metal oxide and hydrogen sulfide (H_2S). The net effect of these reactions is that the quantity of SO_2 in the regenerator is typically reduced between 40 to 65 percent while the quantity of H_2S in the reactor is increased. Generally, the increase in H_2S is handled by sulfur recovery processes located elsewhere within a refinery.

1.7.7 ENHANCED LDAR FOR COMPONENTS IN HEAVY LIQUID SERVICE

Oil refineries, chemical plants, bulk plants, bulk terminals, and other facilities that store, transport and use organic liquids may occasionally have leaks wherever there is a connection between two pieces of equipment, and lose some organic material as fugitive ROG emissions. Valves, pumps, and compressors can also leak organic materials. The District Rule 8-18 requires such facilities to maintain LDAR programs. The rule originally required the monitoring of components in light hydrocarbon liquid service, but was expanded in 2015 to include equipment in heavy hydrocarbon liquid service. Those amendments have not been fully implemented due to litigation regarding uncertainty of heavy liquid fugitive emissions. The District is in the process of conducting studies to determine appropriate emission factors for heavy liquid leaks. Completion of the heavy liquid leak study has been problematic, because some heavy hydrocarbon liquids are condensing and coating the leak detection sensors. The study approach is being re-configured and the results are expected by Fall 2018. The results of the study will be used to determine appropriate revisions to Rule 8-18, e.g., types of monitoring instruments, frequency of monitoring, leak concentration limits, time allowed for repair of the leak, recordkeeping requirements, etc.

1.7.8 SELECTIVE CATALYTIC REDUCTION (SCR) AT PETROLEUM COKE CALCINERS

SCR is post combustion control equipment for NOx control of combustion sources such as boilers and process heaters and is capable of reducing NOx emissions by as much as 95 percent or higher. A typical SCR system consists of an ammonia storage tank, ammonia vaporization and injection equipment, a booster fan for the flue gas exhaust, an SCR reactor with catalyst, and exhaust stack plus ancillary electronic instrumentation and operations control equipment. An SCR system reduces NOx by injecting a mixture of ammonia and air into the flue gas exhaust stream from the combustion equipment. This mixture flows into the SCR reactor where the catalyst, ammonia and oxygen in the flue gas exhaust reacts with NO and NO_2 to form nitrogen and water in the presence of the catalyst. The amount of ammonia introduced into the SCR system is approximately a one-to-one molar ratio of ammonia to NOx for optimum control efficiency, though the ratio may vary based on equipment-specific NOx reduction requirements. SCR catalysts are available in two types of solid, block configurations or modules, plate or honeycomb type, and are comprised of a base material of titanium dioxide that is coated with either tungsten trioxide, molybdic anhydride, vanadium pentoxide, iron oxide, or zeolite catalysts. These catalysts are used for SCRs because of their high activity, insensitivity to sulfur in the exhaust, and useful life span of five years or more. Ultimately, the material composition of the catalyst is dependent upon the application and flue gas conditions such as gas composition, temperature, etc. (SCAQMD, 2015).

For conventional SCRs, the minimum temperature for NOx reduction is 500°F and the maximum operating temperature for the catalyst is 800 °F. The presence of particulates, heavy metals, sulfur compounds, and silica in the flue gas exhaust can limit catalyst performance. Minimizing the quantity of injected ammonia and maintaining the ammonia temperature within a predetermined range helps to avoid these undesirable reactions while minimizing the production of unreacted ammonia which is commonly referred to as "ammonia slip." Depending on the type of combustion equipment utilizing SCR, the typical amount of ammonia slip can vary between less than five ppmv when the catalyst is fresh and 20 ppmv at the end of the catalyst life.

1.7.9 LOTOX (WET SCRUBBER) AT PETROLEUM COKE CALCINERS

The LoTOx™ is a registered trademark of Linde LLC (previously BOC Gases) and was later licensed to BELCO of Dupont for refinery applications. LoTOx™ stands for "Low Temperature Oxidation" process in which ozone (O_3) is used to oxidize insoluble NOx compounds into soluble NOx compounds which can then be removed by absorption in a caustic, lime, or limestone solution. The LoTOx™ process is a low temperature application, optimally operating at about 325 ^{o}F.

A typical combustion process produces about 95 percent NO and five percent NO_2. Because both NO and NO_2 are relatively insoluble in an aqueous solution, a WGS alone is not efficient in removing these insoluble compounds from the flue gas stream. However, with a LoTOx™ system and the introduction of O_3, NO and NO_2 can be easily oxidized into a highly soluble compound N_2O_5 and subsequently converted to nitric acid (HNO_3). Then, in a wet gas scrubber for example, the HNO_3 is rapidly absorbed in caustic (NaOH), limestone or lime solution. The LoTOx™ process can be integrated with any type of wet scrubbers (e.g., venturi, packed beds), semi-dry scrubbers, or wet ESPs. In addition, because the rates of oxidizing reactions for NOx are fast compared to the very slow SO_2 oxidation reaction, no ammonium bisulfate ($(NH_4)HSO_4$) or sulfur trioxide (SO_3) is formed (Confuorto and Sexton, 2007).

CHAPTER 2

ENVIRONMENTAL CHECKLIST

ENVIRONMENTAL CHECKLIST

INTRODUCTION

The environmental checklist provides a standard evaluation tool to identify a project's adverse environmental impacts. This checklist identifies and evaluates potential adverse environmental impacts that may be created by the proposed project.

GENERAL INFORMATION

Project Title:	AB 617 Expedited BARCT Implementation Schedule
Lead Agency Name and Address:	Bay Area Air Quality Management District 375 Beale Street, Suite 600 San Francisco, California 94105
Contact Person:	Guy Gimlen
Contact Phone Number:	415-749-4734
Project Location:	BARCT would apply to industrial sources subject to California GHG Cap-and-Trade requirements within the jurisdiction of the Bay Area Air Quality Management District, which encompasses all of Alameda, Contra Costa, Marin, San Francisco, San Mateo, Santa Clara, and Napa Counties and portions of southwestern Solano and southern Sonoma Counties.
Project Sponsor's Name and Address:	Bay Area Air Quality Management District 375 Beale Street, Suite 600 San Francisco, California 94105
General Plan Designation:	The general plan designation varies as this rule would affect industrial facilities throughout the Bay Area. The majority of affected facilities are located within industrial or commercial designations.
Zoning:	See “General Plan Designation” above.
Description of Project:	See “Background” in Chapter 1.
Surrounding Land Uses and Setting:	See “Affected Area” in Chapter 1.
Other Public Agencies Whose Approval Is Required:	None

ENVIRONMENTAL FACTORS POTENTIALLY AFFECTED:

The following environmental impact areas have been assessed to determine their potential to be affected by the proposed project. Impact areas in which the proposed project may have a significant impact are marked with a "✓". An explanation supporting the determination of significant impacts can be found in the Detailed Checklist and Discussion section below.

☐ Aesthetics	☐ Agriculture and Forestry Resources	☑ Air Quality
☐ Biological Resources	☐ Cultural Resources	☐ Geology / Soils
☐ Greenhouse Gas Emissions	☑ Hazards & Hazardous Materials	☑ Hydrology / Water Quality
☐ Land Use / Planning	☐ Mineral Resources	☐ Noise
☐ Population / Housing	☐ Public Services	☐ Recreation
☐ Transportation / Traffic	☐ Tribal Cultural Resources	☑ Utilities / Service Systems
☑ Mandatory Findings of Significance		

DETERMINATION

On the basis of this initial evaluation:

☐ I find the proposed project COULD NOT have a significant effect on the environment, and that a NEGATIVE DECLARATION will be prepared.

☐ I find that although the proposed project could have a significant effect on the environment, there will not be significant effects in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

☑ I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

☐ I find that the proposed project MAY have a "potentially significant impact" or “potentially significant unless mitigated” impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

☐ I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

Signature: Date:

Printed Name: Date:

EVALUATION OF ENVIRONMENTAL IMPACTS:

1) A brief explanation is required for all answers except "No Impact" answers that are adequately supported by the information sources a lead agency cites in the parentheses following each question. A "No Impact" answer is adequately supported if the referenced information sources show that the impact simply does not apply to projects like the one involved (e.g., the project falls outside a fault rupture zone). A "No Impact" answer should be explained where it is based on project-specific factors as well as general standards (e.g., the project will not expose sensitive receptors to pollutants, based on a project-specific screening analysis.

2) All answers must take account of the whole action involved, including off-site as well as on-site, cumulative as well as project-level, indirect as well as direct, and construction as well as operational impacts.

3) Once the lead agency has determined that a particular physical impact may occur, the checklist answers must indicate whether the impact is potentially significant, less than significant with mitigation, or less than significant. "Potentially Significant Impact" is appropriate if there is substantial evidence that an effect may be significant. If there are one or more "Potentially Significant Impact" entries when the determination is made, an EIR is required.

4) "Negative Declaration: Less Than Significant with Mitigation Incorporated" applies where the incorporation of mitigation measures has reduced an effect from "Potentially Significant Impact" to a "Less Than Significant Impact." The lead agency must describe the mitigation measures, and briefly explain how they reduce the effect to a less than significant level (mitigation measures from "Earlier Analyses," as described in (5) below, may be cross-referenced).

5) Earlier analyses may be used where, pursuant to the tiering, Program EIR, or other CEQA process, an effect has been adequately analyzed in an earlier EIR or negative declaration. Section 15063 (c)(3)(D). In this case, a brief discussion should identify the following:

   a) Earlier Analysis Used. Identify and state where they are available for review.

   b) Impacts Adequately Addressed. Identify which effects from the above checklist were within the scope of and adequately analyzed in an earlier document pursuant to applicable legal standards, and state whether such effects were addressed by mitigation measures based on the earlier analysis.

   c) Mitigation Measures. For effects that are "Less than Significant with Mitigation Measures Incorporated," describe the mitigation measures which were incorporated or refined from the earlier document and the extent to which they address site-specific conditions for the project.

6) Lead agencies are encouraged to incorporate into the checklist references to information sources for potential impacts (e.g., general plans, zoning ordinances). Reference to a

previously prepared or outside document should, where appropriate, include a reference to the page or pages where the statement is substantiated.

7) Supporting Information Sources: A source list should be attached, and other sources used or individuals contacted should be cited in the discussion.

8) This checklist is only a suggested form, and lead agencies are free to use different formats; however, lead agencies should normally address the questions from this checklist that are relevant to a project's environmental effects in whatever format is selected.

9) The explanation of each issue should identify:

   a) the significance criteria or threshold, if any, used to evaluate each question; and

   b) the mitigation measure identified, if any, to reduce the impact to less than significance.

ENVIRONMENTAL CHECKLIST AND DISCUSSION

	Potentially Significant Impact	Less Than Significant Impact With Mitigation Incorporated	Less-than-Significant Impact	No Impact
I. AESTHETICS. Would the project:				
a) Have a substantial adverse effect on a scenic vista?	☐	☐	☑	☐
b) Substantially damage to scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings along a scenic highway?	☐	☐	☑	☐
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	☐	☐	☑	☐
d) Create a new source of substantial light or glare that would adversely affect daytime or nighttime views in the area?	☐	☐	☐	☑

Setting

The Bay Area Air Quality Management District covers all of Alameda, Contra Costa, Marin, San Francisco, San Mateo, Santa Clara, and Napa Counties and portions of southwestern Solano County and southern Sonoma County. The area of coverage is vast (about 5,600 square miles), so that land uses vary greatly and include commercial, industrial, residential, agricultural, and open space uses. Important views of natural features include the San Francisco Bay and ocean, San Francisco Bay, Mount Tamalpais, Mount Diablo, and other peaks and inland valleys of the Coast Range. Cityscape views offered by buildings and distinctive Bay Area bridges, especially the Golden Gate and Bay Bridges and the San Francisco skyline, are also important built visual resources to the region (ABAG, 2017). Views along travel corridors, including roads and rail lines, are in abundance in the Bay Area and include views of the San Francisco Bay, city scape, mountains and hills, redwood groves, and broader views of the ocean and lowlands, such as along ridgelines. Because of the variety of visual resources, scenic highways or corridors are located throughout the Bay Area and includes 15 routes that have been designated as scenic highways and 29 routes eligible for designation as scenic highways (ABAG, 2017).

BARCT would apply to a limited number of industrial sources with physical modifications limited to facilities in industrial or commercial areas. Scenic highways or corridors are generally not located in the vicinity of industrial facilities.

Regulatory Background

Visual resources are generally protected by the City and/or County General Plans through land use and zoning requirements.

Significance Criteria

Project-related impacts on aesthetics and visual resources will be considered significant if any of the following conditions are met:

- The proposed project would have a substantial adverse effect on a scenic vista.
- The proposed project would substantially damage scenic resources, including but not limited to trees, rock outcropping, and historical buildings within a state scenic highway.
- The proposed project would substantially degrade the existing visual character or quality of the site and its surrounds.
- The proposed project would add a visual element of urban character to an existing rural or open space area or add a modern element to a historic area.
- The proposed project would create a new source of substantial light or glare, which would adversely affect day or nighttime views in the area.

Discussion of Impacts

I. a, b, and c). The expedited BARCT implementation schedule would require certain industrial facilities including refineries, manufacturing, bulk storage and transfer operations, cement plants, and petroleum coke calciners to reduce criteria pollutant emissions. These facilities may need to install additional air pollution control equipment, including domes on storage tanks, enclosures on fugitive emission sources, wet gas scrubbers, wet ESPs, SCRs, and LoTOx equipment.

Physical modifications at facilities due to installation of BARCT are expected to be limited to industrial facilities. Air pollution control equipment or measures would be constructed/implemented within the confines of the existing industrial facilities and adjacent to existing industrial structures. Some BARCT measures are not expected to be visible outside of the existing facility. This would include covering portions of petroleum wastewater treatment facilities, lime injection at cement plants, use of SO_2 reducing catalysts, and increased LDAR.

Other BARCT measures would include the installation of equipment that may be visible outside of the existing industrial facilities, however, these facilities are located in industrial areas which do not have scenic views or scenic resources. For example, domes on storage tanks increase the height of the storage tanks making them more visible to the areas surrounding the storage tanks. However, storage tanks are generally located at refineries, bulk handling and storage facilities, or manufacturing facilities and are located within industrial areas. Thus, they are not expected to have significant adverse aesthetic impacts to the surrounding community. Additionally, new air pollution control equipment is not expected to block any scenic vista, degrade the visual character or quality of the area, or result in significant adverse aesthetic impacts.

I. d). The industrial facilities affected by the expedited BARCT requirements may need to install or modify air pollution control equipment to reduce criteria pollutant emissions from their facilities. These facilities are existing industrial facilities that currently operate or can operate 24 hours a day and have existing lighting for nighttime operations. For example, refineries operate continuously 24 hours per day, 7 days per week and are already lighted for nighttime operations. The same is true for most other types of manufacturing operations (e.g., cement plants). Therefore, implementation of the BARCT requirements is not expected to require any additional lighting to be installed as a result of the installation of new air pollution control equipment. New light sources, if any, would be located in industrial areas and are not expected to be noticeable in residential areas. Most local land use agencies have ordinances that limit the intensity of lighting and its effects on adjacent property owners. Therefore, the expedited BARCT requirements are not expected to have significant adverse aesthetic impacts to the surrounding community.

Conclusions

Based upon the above considerations, significant adverse impacts to aesthetics or light and glare are not expected to occur due to implementation of the AB 617 expedited BARCT requirements and, therefore, will not be further evaluated in the Draft EIR.

	Potentially Significant Impact	Less Than Significant Impact With Mitigation Incorporated	Less Than Significant Impact	No Impact
II. AGRICULTURE and FORESTRY RESOURCES. Would the project:				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	☐	☐	☐	☑
b) Conflict with existing zoning for agricultural use or conflict with a Williamson Act contract?	☐	☐	☐	☑
c) Conflict with existing zoning for, or cause rezoning of, forest land as defined in Public Resources Code section 12220(g)), timberland (as defined by Public Resources Code section 4526), or timberland zoned Timberland Production (as defined by Government Code section 51104(g))?	☐	☐	☐	☑
d) Result in the loss of forest land or conversion of forest land to non-forest use?	☐	☐	☐	☑
e) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use or conversion of forest land to non-forest use?	☐	☐	☐	☑

Setting

The Air District covers all of Alameda, Contra Costa, Marin, San Francisco, San Mateo, Santa Clara, and Napa Counties and portions of southwestern Solano and southern Sonoma Counties. The area of coverage is vast (about 5,600 square miles), so that land uses vary greatly and include commercial, industrial, residential, agricultural, and open space uses. Some of these agricultural lands are under Williamson Act contracts. Agricultural land under Williamson Act contract includes both prime and nonprime lands. Prime agricultural land includes land with certain specific soil characteristics, land that has returned a predetermined annual gross value for three of the past five years, livestock-supporting land with specific carrying capacities, or land planted with fruit or nut trees, vines, bushes or crops that have a non-bearing period of less than five years (Government Code §51200-51207). Nonprime lands include pasture and grazing lands and other non-irrigated agricultural lands with lesser soil quality.

The Bay Area has a significant amount of land in agricultural uses. In 2010, approximately over half of the region's approximately 4.5 million acres were classified as agricultural lands, as defined by the California Department of Conservation Farmland Mapping and Monitoring Program. Of these, 2.3 million acres of agricultural land, over 70 percent (about 1.7 million acres) are used for grazing. Products grown in the Bay Area include field crops, fruit and nut crops, seed crops, vegetable crops, and nursery products. Field crops, which include corn, wheat, and oats, as well as pasture lands, represent approximately 62 percent of the Bay Area agricultural land (ABAG, 2017). In 2014, about 1.25 million acres of land were under Williamson Act contract in the Bay Area. Of this, about 203,200 acres were prime farmland and one million acres were nonprime. Lands under Williamson Act contract are primarily used for pasture and grazing and not for cultivation of crops. Approximately 70 percent of prime farmlands under contract are in Santa Clara, Solano, and Sonoma counties (ABAG, 2017).

Expedited BARCT requirements would affect a limited number of facilities with physical modifications limited to facilities in industrial areas that are zoned for industrial use and agricultural or forest lands are not located within these areas or facilities.

Regulatory Background

Agricultural and forest resources are generally protected by the City and/or County General Plans, Community Plans through land use and zoning requirements, as well as any applicable specific plans, ordinances, local coastal plans, and redevelopment plans.

Significance Criteria

Project-related impacts on agriculture and forest resources will be considered significant if any of the following conditions are met:

- The proposed project conflicts with existing zoning or agricultural use or Williamson Act contracts.
- The proposed project will convert prime farmland, unique farmland or farmland of statewide importance as shown on the maps prepared pursuant to the farmland mapping and monitoring program of the California Resources Agency, to non-agricultural use.
- The proposed project conflicts with existing zoning for, or causes rezoning of, forest land (as defined in Public Resources Code §12220(g)), timberland (as defined in Public Resources Code §4526), or timberland zoned Timberland Production (as defined by Government Code § 51104 (g)).
- The proposed project would involve changes in the existing environment, which due to their location or nature, could result in conversion of farmland to non-agricultural use or conversion of forest land to non-forest use.

Discussion of Impacts

II a-e. The expedited BARCT implementation schedule would require certain industrial facilities including refineries, manufacturing, bulk storage and transfer operations, cement plants, and petroleum coke calciners to reduce criteria pollutant emissions. These facilities may need to install additional air pollution control equipment, including domes on storage tanks, enclosures on fugitive emission sources, wet gas scrubbers, wet ESPs, SCRs, and LoTOx equipment.

Physical modifications at facilities due to installation of BARCT are expected to be limited to industrial facilities. Air pollution control equipment or measures would be constructed/implemented within the confines of the existing industrial facilities and adjacent to existing industrial structures. This equipment would be compatible with the existing industrial character and land use of the area and would not be located in agricultural or forestland areas. Thus, no impacts to agriculture and forestry resources are expected.

The proposed project would not conflict with existing agriculture related zoning designations or Williamson Act contracts. Existing agricultural and forest resources within the boundaries of the Air District are not expected to be affected by the construction of additional air pollution control equipment or modification to existing emission sources. Therefore, there is no potential for conversion of farmland to non-agricultural use or conflicts related to agricultural uses or land under a Williamson Act contract, or impacts to forestland resources.

Conclusion

Based upon the above considerations, significant adverse impacts to agricultural or forestry resources are not expected to occur due to implementation of the AB 617 expedited BARCT requirements and, therefore, will not be further evaluated in the Draft EIR.

	Potentially Significant Impact	Less Than Significant Impact With Mitigation Incorporated	Less Than Significant Impact	No Impact
III. AIR QUALITY. Would the project:				
a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☐	☐	☑
b) Violate any air quality standard or contribute to an existing or projected air quality violation?	☑	☐	☐	☐
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is a nonattainment area for an applicable federal or state ambient air quality standard (including releasing emissions that exceed quantitative thresholds for ozone precursors)?	☑	☐	☐	☐
d) Expose sensitive receptors to substantial pollutant concentrations?	☑	☐	☐	☐
e) Create objectionable odors affecting a substantial number of people?	☐	☐	☑	☐

Setting

It is the responsibility of the Air District to ensure that state and federal ambient air quality standards are achieved and maintained in its geographical jurisdiction. Health-based air quality standards have been established by California and the federal government for the following criteria air pollutants: ozone, carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter less than 10 microns in diameter (PM_{10}), particulate matter less than 2.5 microns in diameter ($PM_{2.5}$), and lead.

The San Francisco Bay Area is characterized by a large, shallow basin surrounded by mountain ranges tapering into sheltered inland valleys. The basin is bounded by the Pacific Ocean to the west and includes complex terrain consisting of mountains, valleys and bays. Combined climatic and topographic factors result in increased potential for the accumulation of air pollutants in the inland valleys and reduced potential for buildup of air pollutants along the coast.

Air quality conditions in the San Francisco Bay Area have improved greatly since the Air District was created in 1955, and regional concentrations of criteria pollutants are now in compliance with or near compliance with most ambient air quality standards. The Bay Area is in attainment with both the National Ambient Air Quality Standards and the California Ambient Air Quality Standards for CO, SO_2, NO_2, and lead. The air basin is designated as nonattainment for ozone and particulate matter (PM_{10} and $PM_{2.5}$) under the California ambient air quality standards.

Regulatory Background

Criteria Pollutants

At the federal level, the Clean Air Act (CAA) Amendments of 1990 give the U.S. EPA additional authority to require states to reduce emissions of ozone precursors and particulate matter in non-attainment areas. The amendments set attainment deadlines based on the severity of problems. At the state level, CARB has traditionally established state ambient air quality standards, maintained oversight authority in air quality planning, developed programs for reducing emissions from motor vehicles, developed air emission inventories, collected air quality and meteorological data, and approved state implementation plans. At a local level, California's air districts, including the Bay Area Air Quality Management District, are responsible for overseeing stationary source emissions, approving permits, maintaining emission inventories, maintaining air quality stations, overseeing agricultural burning permits, and reviewing air quality-related sections of environmental documents required by CEQA.

The Air District is governed by a 24-member Board of Directors composed of publicly-elected officials apportioned according to the population of the represented counties. The Board has the authority to develop and enforce regulations for the control of air pollution within its jurisdiction. The Air District is responsible for implementing emissions standards and other requirements of federal and state laws. It is also responsible for developing air quality planning documents required by both federal and state laws.

Toxic Air Contaminants

TACs are regulated in the District through federal, state, and local programs. At the federal level, TACs are regulated primarily under the authority of the CAA. Prior to the amendment of the CAA in 1990, source-specific NESHAPs were promulgated under Section 112 of the CAA for certain sources of radionuclides and Hazardous Air Pollutants (HAPs).

Title III of the 1990 CAA amendments requires U.S. EPA to promulgate NESHAPs on a specified schedule for certain categories of sources identified by U.S. EPA as emitting one or more of the 189 listed HAPs. Emission standards for major sources must require the maximum achievable control technology (MACT). MACT is defined as the maximum degree of emission reduction achievable considering cost and non-air quality health and environmental impacts and energy requirements. All NESHAPs were to be promulgated by the year 2000. Specific incremental progress in establishing standards were to be made by the years 1992 (at least 40 source categories), 1994 (25 percent of the listed categories), 1997 (50 percent of remaining listed categories), and 2000 (remaining balance). The 1992 requirement was met; however, many of the four-year standards were not promulgated as scheduled. Promulgation of those standards has been rescheduled based on court ordered deadlines, or the aim to satisfy all Section 112 requirements in a timely manner.

Many of the sources of TACs that have been identified under the CAA are also subject to the California TAC regulatory programs. CARB developed regulatory programs for the control of TACs, including: (1) California's TAC identification and control program, adopted in 1983 as Assembly Bill 1807 (AB 1807) (California Health and Safety Code §39662), a two-step program in which substances are identified as TACs, and airborne toxic control measures (ATCMs) are adopted to control emissions from specific sources; and (2) The Air Toxics Hot Spot Information and Assessment Act of 1987 (AB 2588) (California

Health and Safety Code §39656) established a state-wide program to inventory and assess the risks from facilities that emit TACs and to notify the public about significant health risks associated with those emissions.

In 2004, the Air District initiated the Community Air Risk Evaluation (CARE) program to identify areas with relatively high concentrations of air pollution–including toxic air contaminants (TACs) and fine particulate matter–and populations most vulnerable to air pollution's health impacts. Maps of communities most impacted by air pollution, generated through the CARE program, have been integrated into many District programs. For example, the Air District uses information derived from the CARE program to develop and implement targeted risk reduction programs, including grant and incentive programs, community outreach efforts, collaboration with other governmental agencies, model ordinances, new regulations for stationary sources and indirect sources, and advocacy for additional legislation.

Significance Criteria

On June 2, 2010, the District's Board of Directors unanimously adopted thresholds of significance to assist in the review of projects under CEQA. These CEQA thresholds were designed to establish the level at which the District believed air pollution emissions would cause significant environmental impacts under CEQA. The CEQA thresholds were challenged in court. Following litigation in the trial court, the court of appeal, and the California Supreme Court, all of the Thresholds were upheld. However, in an opinion issued on December 17, 2015, the California Supreme Court held that CEQA does not generally require an analysis of the impacts of locating development in areas subject to environmental hazards unless the project would exacerbate existing environmental hazards.

In view of the Supreme Court's opinion, local agencies may rely on the District's CEQA thresholds designed to reflect the impact of locating development near areas of toxic air contamination where such an analysis is required by CEQA or where the agency has determined that such an analysis would assist in making a decision about the project. However, the CEQA thresholds are not mandatory and agencies should apply them only after determining that they reflect an appropriate measure of a project's impacts.

The Air District published a new version of the Guidelines dated May 2017, which includes revisions made to address the Supreme Court's opinion. The CEQA Guidelines for implementation of the Thresholds are for information purposes only to assist local agencies. Recommendations in the Guidelines are advisory and should be followed by local governments at their own discretion. The Air District is currently working to revise any outdated information in the Guidelines as part of its update to the CEQA Guidelines and thresholds of significance. Since these are the most current air quality significance thresholds and address court decisions, they will be used in the CEQA analysis for the current project.

Construction Emissions

Regarding construction emissions, the Air District's 2017 Thresholds of Significance will be used in the current air quality analysis for construction emissions (see Table 2-1).

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TABLE 2-1

Thresholds of Significance for Construction-Related Criteria Air Pollutants and Precursors

Pollutant/Precursor	Daily Average Emissions (lbs/day)
ROG	54
NOx	54
PM_{10}	82*
$PM_{2.5}$	54*
PM_{10}/ $PM_{2.5}$ Fugitive Dust	Best Management Practices

*Applies to construction exhaust emissions only.
Source: BAAQMD, 2017

Operational Emissions

The most recently available CEQA Guidelines established emission thresholds for specific projects, general plans, and regional plans. An air quality rule does not fall neatly into any of these categories. Air quality rules are typically regional in nature, as opposed to general plans, community plans and regional plans. In addition, air quality rules are usually specific to particular source types and particular pollutants. The Air Quality Plan threshold of "no net increase in emissions" is appropriate for Air Quality Plans because they include a mix of control measures with individual trade-offs. For example, one control measure may result in combustion of methane to reduce greenhouse gas emissions, while increasing criteria pollutant emissions by a small amount. Those increases from the methane measure would be offset by decreases from other measures focused on reducing criteria pollutants. In a particular rule development effort, there may not be opportunities to make these trade-offs.

The 2017 project-level stationary source CEQA thresholds are identified in Table 2-2. These represent the levels at which an individual project's emissions would result in a cumulatively considerable contribution to the Air District's existing air quality conditions. The Air District does not currently have significance thresholds specifically for rules. In order to provide a conservative air quality analysis, the project-specific thresholds recommended in the revised 2017 CEQA Guidelines (BAAQMD, 2017) will be used in the current air quality impacts analysis (see Table 2-2).

TABLE 2-2

Thresholds of Significance for Operation-Related Criteria Air Pollutants and Precursors

Pollutant/Precursor	Daily Average Emissions (lbs/day)	Maximum Annual Emissions (tons/year)
ROG	54	10
NOx	54	10
PM_{10}	82	15
$PM_{2.5}$	54	10

*Source: BAAQMD, 2017

Discussion of Impacts

III a. The proposed expedited BARCT requirements are not expected to conflict with or obstruct implementation of the applicable air quality plan. The applicable air quality plan is the Air District's recently-adopted 2017 Clean Air Plan, *Spare the Air, Cool the Climate*. The Plan outlines a strategy for achieving the Bay Area's clean air goals by reducing emissions of ozone precursors, particulate matter, and other pollutants in the region. The proposed expedited BARCT schedule will not conflict with or obstruct implementation of the 2017 Clean Air Plan, rather it will help achieve the Plan's goals by helping to reduce criteria pollutant emissions, including emissions of ozone precursors (ROG and NOx) and particulate matter or precursors to particulates (NOx and SO_2), thus improving public health and air quality in the region.

III b, c and d. While the primary purpose of implementing expedited BARCT requirements is to reduce emissions of ROG, NOx, SO_2, and PM, some types of control equipment have the potential to create secondary adverse air quality impacts, through construction activities or through the addition of air pollution control equipment (e.g., SCRs). The proposed expedited BARCT schedule may result in the installation of new equipment at facilities that need to comply with the new requirements.

Limited construction activities may be required for some BARCT measures to enclose open fugitive components, install new catalyst, increase lime injection and so forth. Construction emissions associated with this type of construction would be minor and would involve the transport of the new equipment which is expected to require one to two truck trips per project. Installation of the equipment would be expected to be limited to two to ten workers and would not require any major construction equipment and no site preparation activities would be expected to be required. Therefore, retrofitting this type of existing equipment would result in minor construction emissions.

Construction activities would also be required for the construction of new air pollution control equipment at existing facilities, including vapor combustors, wet gas scrubbers, ESPs, vapor recovery systems, and SCRs. Some of the BARCT equipment would be required at existing facilities with large emission sources, e.g., refinery FCCUs. Construction activities for these types of new air pollution control equipment could be substantial because the control equipment would be needed on large sources and would need to be appropriately sized. Construction activities associated with air pollution control equipment at large sources could be substantial and generate significant, although temporary construction emissions.

Although the primary effect of installing air pollution control equipment is to reduce emissions of a particular pollutant, e.g., NOx, some types of control equipment have the potential to create secondary adverse air quality impacts. For example, control strategies aimed at reducing NOx from stationary sources may use ammonia for control (e.g., selective catalytic reduction). Ammonia use could result in increased ammonia emissions and, since ammonia is a precursor to particulate formation, increased particulate formation in the atmosphere. Because of the potential for secondary emissions from air pollution control equipment, there is also a potential that sensitive receptors could be exposed to increased pollutant concentrations, which may be significant. As a result, these potential air quality impacts of the expedited BARCT measures will be evaluated in the Draft EIR.

III e. The implementation of expedited BARCT is expected to result in emission decreases associated with control of criteria pollutant emissions, including SOx emissions. Some sulfur compounds have odors. However, a number of methods to reduce SOx emissions involve removing additional sulfur compounds, reducing the potential for odors in downstream equipment.

Odors associated with ammonia use in new SCR systems are expected to be minimal. Ammonia can have a strong odor; however, new SCRs are not expected to generate substantial ammonia emissions. Ammonia is generally stored in an enclosed pressurized tank, which prevents fugitive ammonia emissions. Ammonia emissions from the stack (also referred to as ammonia slip) are expected to be limited to 10 ppm and implemented through permit conditions. Since exhaust emissions are buoyant as a result of being heated, ammonia in the exhaust will disperse and ultimate ground level concentrations would be expected to be substantially lower than five ppm. Five ppm is below the odor threshold for ammonia of 20 ppm (OSHA, 2005). Potential odor impacts associated with the expedited BARCT requirements are not expected to be significant. The Air District will continue to enforce odor nuisance complaints through BAAQMD Regulation 7, Odorous Substances.

Conclusion

Implementation of expedited BARCT requirements would reduce ROG, SO_2, PM and NOx emissions from industrial facilities that operate stationary large emission sources throughout the Bay Area. However, construction and operation of new air pollution control systems have the potential to increase emissions of other criteria pollutants and generate localized impacts. Therefore, potential adverse secondary air quality impacts which could result from implementing expedited BARCT requirements will be evaluated in the Draft EIR. No significant impacts were identified on air quality plans or the generation of odors and these topics will not be addressed further in the Draft EIR.

	Potentially Significant Impact	Less Than Significant Impact With Mitigation Incorporated	Less Than Significant Impact	No Impact
IV. BIOLOGICAL RESOURCES. Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Wildlife or U.S. Fish and Wildlife Service?	☐	☐	☐	☑
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, or regulations, or by the California Department of Fish and Wildlife or U.S. Fish and Wildlife Service?	☐	☐	☐	☑
c) Have a substantial adverse effect on federally protected wetlands as defined by §404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal wetlands, etc.) through direct removal, filling, hydrological interruption, or other means?	☐	☐	☐	☑
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?	☐	☐	☐	☑
e) Conflicting with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	☐	☐	☐	☑
f) Conflict with the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, or state habitat conservation plan?	☐	☐	☐	☑

Setting

The Air District covers all of Alameda, Contra Costa, Marin, San Francisco, San Mateo, Santa Clara, and Napa Counties and portions of southwestern Solano and southern Sonoma Counties. The area of coverage is vast (about 5,600 square miles), so that land uses vary greatly and include commercial, industrial, residential, agricultural, and open space uses. A wide variety of biological resources are located within the Bay Area.

The Bay Area supports numerous distinct natural communities composed of a diversity of vegetative types that provide habitat for a wide variety of plant and wildlife species. Broad habitat categories in the region include grasslands, coastal scrubs and chaparral, woodlands and forests, riparian systems and freshwater aquatic habitat, and wetlands. Extensive aquatic resources are provided by the San Francisco Bay Delta estuary, as well as numerous other rivers and streams. Urban and otherwise highly disturbed habitats, such as agricultural fields, also provide natural functions and values as wildlife habitat (ABAG, 2017).

Expedited BARCT requirements would affect a limited number of facilities with physical modifications limited to facilities in industrial areas that are zoned for industrial use. Biological resources are not usually located in industrial areas.

Regulatory Background

Biological resources are generally protected by the City and/or County General Plans through land use and zoning requirements which minimize or prohibit development in biologically sensitive areas. Biological resources are also protected by the California Department of Fish and Wildlife, and the U.S. Fish and Wildlife Service. The U.S. Fish and Wildlife Service and National Marine Fisheries Service oversee the federal Endangered Species Act. Development permits may be required from one or both of these agencies if development would impact rare or endangered species. The California Department of Fish and Wildlife administers the California Endangered Species Act which prohibits impacting endangered and threatened species. The U.S. Army Corps of Engineers and the U.S. EPA regulate the discharge of dredge or fill material into waters of the United States, including wetlands.

Significance Criteria

The proposed project impacts on biological resources will be considered significant if:

- The project results in a loss of plant communities or animal habitat considered to be rare, threatened or endangered by federal, state or local agencies.
- The project interferes substantially with the movement of any resident or migratory wildlife species.
- The project adversely affects aquatic communities through construction or operation of the project.

Discussion of Impacts

IV a, b, c and d). The expedited BARCT implementation schedule would require certain industrial facilities including refineries, manufacturing, bulk storage and transfer operations, cement plants, and petroleum coke calciners to reduce criteria pollutant emissions. These facilities may need to install additional air pollution control equipment, including domes on storage tanks, enclosures on fugitive emission sources, wet gas scrubbers, wet ESPs, SCRs, and LoTOx equipment.

Physical modifications at facilities due to installation of BARCT are expected to be limited to industrial facilities. Air pollution control equipment or measures would be constructed/implemented within the confines of the existing industrial facilities and adjacent to existing industrial structures. These facilities have been built and graded and no major grading would be expected to occur due to the installation of additional air pollution control equipment. Construction activities would occur within industrial areas, where native biological resources have been removed or are non-existent. Thus, the proposed project is not expected to result in any impacts to biological resources.

IV e and f). The proposed project is not expected to affect land use plans, local policies or ordinances, or regulations protecting biological resources such as a tree preservation policy or ordinances for the reasons already given. Land use and other planning considerations are determined by local governments and land use or planning requirements are not expected to be altered by the proposed project. Similarly, the proposed BARCT requirements are not expected to affect any habitat conservation or natural community conservation plans, biological resources or operations, and would not create divisions in any existing communities, as construction activities would be limited to existing facilities in industrial areas that have already been developed and graded.

Conclusion

Based upon the above considerations, significant adverse project-specific impacts to biological resources are not expected to occur due to implementation of the expedited BARCT requirements and, therefore, will not be further evaluated in the Draft EIR.

	Potentially Significant Impact	Less Than Significant Impact With Mitigation Incorporated	Less Than Significant Impact	No Impact
V. CULTURAL RESOURCES. Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	☐	☐	☐	☑
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?	☐	☐	☐	☑
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☐	☐	☑
d) Disturb any human remains, including those interred outside of formal cemeteries?	☐	☐	☐	☑

Setting

The Air District covers all of Alameda, Contra Costa, Marin, San Francisco, San Mateo, Santa Clara, and Napa Counties and portions of southwestern Solano and southern Sonoma Counties. The area of coverage is vast (about 5,600 square miles), so that land uses vary greatly and include commercial, industrial, residential, agricultural, and open space uses. Cultural resources are defined as buildings, sites, structures, or objects which might have historical architectural, archaeological, cultural, or scientific importance. Cultural resources also include paleontological sites, which can consist of mineralized, partially mineralized, or unmineralized bones and teeth, soft tissues, shells, wood, leaf impressions, footprints, burrows, and microscopic remains that are more than 5,000 years old and occur mainly in Pleistocene or older sedimentary rock units.

The Carquinez Strait represents the entry point for the Sacramento and San Joaquin Rivers into the San Francisco Bay. This locality lies within the San Francisco Bay and the west end of the Central Valley archaeological regions, both of which contain a rich array of prehistoric and historical cultural resources. The areas surrounding the Carquinez Strait and Suisun Bay have been occupied for millennia given their abundant combination of littoral and oak woodland resources.

Important vertebrate and invertebrate fossils and unique geologic units have been documented throughout California. The fossil yielding potential of a particular area is highly dependent on the geologic age and origin of the underlying rocks. Pleistocene or older (older than 11,000 years) continental sedimentary deposits are considered to have a high paleontological potential while Holocene-age deposits (less than 10,000 years old) are generally considered to have a low paleontological potential because they are geologically immature and are unlikely to contain fossilized remains of organisms. Metamorphic and igneous rocks have a low paleontological potential, either because they formed beneath the surface of the earth (such as granite), or because they have been altered under heat and high pressures.

Historic resources are standing structures of historic or aesthetic significance. Architectural sites dating from the Spanish Period (1529-1822) through the late 1960s are generally considered for protection if they are determined to be historically or architecturally significant. These may include missions, historic ranch lands, and structures from the Gold Rush and the region's early industrial era. More recent architectural sites may also be considered for protection if they could gain historic significance in the future (ABAG, 2017).

Of the 8,199 sites recorded in the Bay Area, there are 1,006 cultural resources listed on the California Register of Historic Resources (CRHR), meaning that they are significant at the local, State or federal level; of those, 744 are also listed on the National Register of Historic Places (NRHP). From this list, 249 resources are listed as California Historic Landmarks. The greatest concentration of historic resources listed on both the NRHP and the CRHR in the Bay Area occurs in San Francisco, with 181 resources. Alameda County has the second highest number with 147 resources (ABAG, 2017).

Expedited BARCT requirements would affect a limited number of facilities, with physical modifications limited to facilities in industrial areas that are zoned for industrial use which have been graded and developed.

Regulatory Background

The State CEQA Guidelines define a significant cultural resource as a "resource listed or eligible for listing on the California Register of Historical Resources" (Public Resources Code Section 5024.1). A project would have a significant impact if it would cause a substantial adverse change in the significance of a historical resource (State CEQA Guidelines Section 15064.5(b)). A substantial adverse change in the significance of a historical resource would result from an action that would demolish or adversely alter the physical characteristics of the historical resource that convey its historical significance and that qualify the resource for inclusion in the California Register of Historical Resources or a local register or survey that meets the requirements of Public Resources Code §§50020.1(k) and 5024.1(g).

Significance Criteria

The proposed project impacts to cultural resources will be considered significant if:

- The project results in the disturbance of a significant prehistoric or historic archaeological site or a property of historic or cultural significance to a community or ethnic or social group.
- Unique paleontological resources are present that could be disturbed by construction of the proposed project.
- The project would disturb human remains.

Discussion of Impacts

V a, b, c and d). CEQA Guidelines state that generally, a resource shall be considered 'historically significant' if the resource meets the criteria for listing in the California Register of Historical Resources including the following:

A. Is associated with events that have made a significant contribution to the broad patterns of California's history and cultural heritage;

B. Is associated with the lives of persons important in our past;

C. Embodies the distinctive characteristics of a type, period, region, or method of construction, or represents the work of an important creative individual, or possesses high artistic values;

D. Has yielded or may be likely to yield information important in prehistory or history (CEQA Guidelines §15064.5).

Generally, resources (buildings, structures, equipment) that are less than 50 years old are excluded from listing in the National Register of Historic Places unless they can be shown to be exceptionally important. The expedited BARCT requirements would result in control measures and new air pollution control equipment to be constructed within the confines of the existing industrial facilities and adjacent to existing industrial structures. Affected facilities may have equipment or structures older than 50 years, however, this type of equipment does not meet the criteria identified in CEQA Guidelines §15064.5(a)(3). Further, construction activities associated with the proposed project are expected to be limited to industrial areas that have already been developed. Thus, the proposed BARCT requirements would not adversely affect historical or archaeological resources as defined in CEQA Guidelines §15064.5, destroy unique paleontological resources or unique geologic features, or disturb human remains interred outside formal cemeteries. Therefore, no impacts to cultural resources are anticipated to occur as a result of the proposed project as no major construction activities are required.

Conclusion

Based upon the above considerations, significant adverse project-specific impacts to cultural resources are not expected to occur due to implementation of the expedited BARCT requirements and, therefore, will not be further evaluated in the Draft EIR.

	Potentially Significant Impact	Less Than Significant Impact With Mitigation Incorporated	Less Than Significant Impact	No Impact
VI. GEOLOGY AND SOILS. Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☑	☐
ii) Strong seismic ground shaking?	☐	☐	☑	☐
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☑	☐
iv) Landslides?	☐	☐	☑	☐
b) Result in substantial soil erosion or the loss of topsoil?	☐	☐	☐	☑
c) Be located on a geologic unit or soil that is unstable or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?	☐	☐	☐	☑
d) Be located on expansive soil, as defined in Table 18-1-B of the California Building Code (1994) (formerly referred to as the Uniform Building Code), creating substantial risks to life or property?	☐	☐	☐	☑
e) Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems in areas where sewers are not available for the disposal of wastewater?	☐	☐	☐	☑

Setting

California has 11 natural geologic regions, known as geomorphic provinces, which are defined by the presence of similar physical characteristics, such as relief, landforms, and geology. Most of the Bay Area is located within the natural region of California known as the Coast Ranges geomorphic province, with the eastern portions of Contra Costa and Alameda Counties extending into the neighboring Great Valley geomorphic province, located east of the Coast Ranges. The Coast Range, extends about 400 miles from Oregon south into Southern California, and is characterized by a series of northwest trending ridges and valleys that roughly parallel the San Andreas fault zone. The San Francisco Bay is a broad, shallow regional structural depression created from an east-west expansion between the San Andreas and the Hayward fault systems.

Much of the Coast Range province is composed of marine sedimentary and volcanic rocks located east of the San Andreas Fault. The regional west of the San Andreas Fault is underlain by a mass of basement rock that is composed of mainly marine sandstone and various metamorphic rocks. Marginal lands surrounding San Francisco Bay consist generally of alluvial plains of low relief that slope gently towards the bay from bordering uplands and foothills (ABAG, 2017). Unconsolidated alluvial deposits, artificial fill, and estuarine deposits, (including Bay Mud) underlie the low-lying region along the margins of the Carquinez Straight and Suisun Bay. The organic, soft, clay-rich sediments along the San Francisco and San Pablo Bays are referred to locally as Bay Mud and can present a variety of engineering challenges due to inherent low strength, compressibility and saturated conditions. Landslides in the region occur in weak, easily weathered bedrock on relatively steep slopes.

The San Francisco Bay Area is a seismically active region, which is situated on a tectonic plate boundary marked by the San Andreas Fault System. Under the Alquist-Priolo Earthquake Fault Zoning Act, Earthquake Fault Zones were established by the California Division of Mines and Geology along “active” faults, or faults along which surface rupture occurred in Holocene time (the last 11,000 years). The San Andreas and the Hayward faults are the two faults considered to have the highest probabilities of causing a significant seismic event in the Bay Area. These two faults are classified as strike-slip faults that have experienced movement within the last 150 years. Other principal faults capable of producing significant ground shaking in the Bay Area are included in Table 2-3, and include the Rodgers Creek-Healdsburg, Concord-Green Valley, Marsh Creek-Greenville, San Gregorio-Hosgri, West Napa and Calaveras faults (ABAG, 2017). A major seismic event on any of these active faults could cause significant ground shaking and surface fault rupture. Other smaller faults in the region classified as potentially active include the Southampton and Franklin faults.

Ground movement intensity during an earthquake can vary depending on the overall magnitude, distance to the fault, focus of earthquake energy, and type of geological material. Areas that are underlain by bedrock tend to experience less ground shaking than those underlain by unconsolidated sediments such as artificial fill. Earthquake ground shaking may have secondary effects on certain foundation materials, including liquefaction, seismically induced settlement, and lateral spreading.

TABLE 2-3

Active Faults in the Bay Area

Fault	Recency of Movement	Maximum Moment Magnitude Earthquake
San Andreas	1989	7.9
Hayward	1868	7.1
Rodgers Creek-Healdsburg	1969	7.0
Concord-Green Valley	1955	6.9
Marsh Creek-Greenville	1980	6.9
San Gregorio-Hosgri	Late Quaternary	7.3
West Napa	2000	6.5
Maacama	Holocene	7.1
Calaveras	1990	6.8
Mount Diablo Thrust	Quaternary	6.7

(Source: ABAG, 2017)

Regulatory Background

Construction is regulated by the local City or County building codes that provide requirements for construction, grading, excavations, use of fill, and foundation work including type of materials, design, procedures, etc. which are intended to limit the probability of occurrence and the severity of consequences from geological hazards. Necessary permits, plan checks, and inspections are generally required.

The City or County General Plan includes the Seismic Safety Element. The Element serves primarily to identify seismic hazards and their location in order that they may be taken into account in the planning of future development. The California Building Code is the principle mechanism for protection against and relief from the danger of earthquakes and related events.

In addition, the Seismic Hazard Zone Mapping Act (Public Resources Code §§2690 – 2699.6) was passed by the California legislature in 1990 following the Loma Prieta earthquake. The Act required that the California Division of Mines and Geology (DMG) develop maps that identify the areas of the state that require site specific investigation for earthquake-triggered landslides and/or potential liquefaction prior to permitting most urban developments. The act directs cities, counties, and state agencies to use the maps in their land use planning and permitting processes.

Local governments are responsible for implementing the requirements of the Seismic Hazards Mapping Act. The maps and guidelines are tools for local governments to use in establishing their land use management policies and in developing ordinances and reviewing procedures that will reduce losses from ground failure during future earthquakes.

Significance Criteria

The proposed project impacts on the geological environment will be considered significant if:

- Topographic alterations would result in significant changes, disruptions, displacement, excavation, compaction or over covering of large amounts of soil.
- Unique geological resources (paleontological resources or unique outcrops) are present that could be disturbed by the construction of the proposed project.
- Exposure of people or structures to major geologic hazards such as earthquake surface rupture, ground shaking, liquefaction or landslides.
- Secondary seismic effects could occur which could damage facility structures, e.g., liquefaction.
- Other geological hazards exist which could adversely affect the facility, e.g., landslides, mudslides.

Discussion of Impacts

VI a, c, and d). The expedited BARCT implementation schedule would require certain industrial facilities including refineries, manufacturing, bulk storage and transfer operations, cement plants, and petroleum coke calciners to reduce criteria pollutant emissions. These facilities may need to install additional air pollution control equipment, including domes on storage tanks, enclosures on fugitive emission sources, wet gas scrubbers, wet ESPs, SCRs, and LoTOx equipment.

Physical modifications at facilities due to installation of BARCT are expected to be limited to industrial facilities. New development potentially resulting in earthquake hazards is expected to be limited to the construction of air pollution control equipment or measures at industrial facilities. New construction (including modifications to existing structures) requires compliance with the California Building Code. The California Building Code is considered to be a standard safeguard against major structural failures and loss of life. The goal of the code is to provide structures that will: (1) resist minor earthquakes without damage; (2) resist moderate earthquakes without structural damage, but with some non-structural damage; and (3) resist major earthquakes without collapse, but with some structural and non-structural damage. The California Building Code bases seismic design on minimum lateral seismic forces (“ground shaking”). The California Building Code requirements operate on the principle that providing appropriate foundations, among other aspects, helps to protect buildings from failure during earthquakes. The basic formulas used for the California Building Code seismic design require determination of the seismic zone and site coefficient, which represent the foundation conditions at the site. Compliance with the California Building Code would minimize the impacts associated with existing geological hazards.

VI b). Construction associated with the proposed project is expected to be limited to air pollution control equipment at industrial facilities. All construction would take place at already existing facilities that have been previously graded. Thus, the proposed project is not expected to result in substantial soil erosion or the loss of topsoil as construction activities are expected to be limited to existing operating facilities that have been graded and developed, so that no major grading would be required.

VI e). Septic tanks or other similar alternative wastewater disposal systems are typically associated with small residential projects in remote areas. The expedited BARCT requirements would affect industrial facilities that have existing wastewater treatment systems or which are connected to appropriate wastewater facilities and do not rely on septic tanks or similar alternative wastewater disposal systems. Based on these considerations, septic tanks or other alternative wastewater disposal systems are not expected to be impacted by the proposed project.

Conclusion

Based upon the above considerations, significant adverse project-specific impacts to geology and soils are not expected to occur due to implementation of the expedited BARCT requirements and, therefore, will not be further evaluated in the Draft EIR.

	Potentially Significant Impact	Less Than Significant Impact With Mitigation Incorporated	Less Than Significant Impact	No Impact
VII. GREENHOUSE GAS EMISSIONS AND CLIMATE CHANGE. Would the project:				
a) Generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?	☐	☐	☑	☐
b) Conflict with an applicable plan, policy or regulation adopted for the purpose of reducing the emissions of greenhouse gases?	☐	☐	☑	☐

Setting

Global climate change refers to changes in average climatic conditions on the earth as a whole, including temperature, wind patterns, precipitation and storms. Global climate change is caused primarily by an increase in levels of greenhouse gases (GHGs) in the atmosphere. The major greenhouse gases are the so-called "Kyoto Six" gases – carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs) – as well as black carbon.[1] These greenhouse gases absorb longwave radiant energy (heat) reflected by the earth, which warms the atmosphere in a phenomenon known as the "greenhouse effect." The potential effects of global climate change include rising surface temperatures, loss in snow pack, sea level rise, ocean acidification, more extreme heat days per year, and more drought years.

Increases in the combustion of fossil fuels (e.g., gasoline, diesel, coal, etc.) since the beginning of the industrial revolution have resulted in a significant increase in atmospheric levels of greenhouse gases. CO_2 levels have increased from long-term historical levels of around 280 ppm before the mid-18th century to over 400 ppm today. This increase in greenhouse gases has already caused noticeable changes in the climate. The average global temperature has risen by approximately 1.4°F (0.8°C) over the past one hundred years, and 16 of the 17 hottest years in recorded history have occurred since 2001, according to the National Oceanic and Atmospheric Administration.

Total global greenhouse gas emissions contributing to climate change are in the tens of billions of metric tons of CO_2e (carbon dioxide equivalent) per year. The State of California alone produces about two percent of the entire world's GHG emissions with major emitting sources including fossil fuel consumption from transportation (37 percent), electricity production (20 percent), industry (24 percent), agricultural and forestry (8 percent), residential activities (6 percent), and commercial activities (5 percent) (ABAG, 2017). The Bay Area's contribution to the global total is approximately 85 million tons

[1] Technically, black carbon is not a gas but is made up of solid particulates or aerosols. It is included in the discussion of greenhouse gas emissions because, like true greenhouse gases, it is an important contributor to global climate change.

per year. Transportation sources generate approximately 40 percent of the total GHG emissions in the Bay Area, with the remaining 60 percent coming from stationary and area sources (BAAQMD, 2017).

Regulatory Background

California has committed to reducing its greenhouse gas emissions to 1990 levels by 2020, to 40 percent below 1990 levels by 2030, and to 80 percent below 1990 levels by 2050. This commitment was enacted in AB 32, the Global Warming Solutions Act of 2006, which adopted the 2020 target; in 2016's SB 32 (Pavley), which adopted the 2030 target; and in Executive Order S-3-05, which adopted the 2050 target. The Air District has adopted the same 80 percent reduction target for 2050 for the Bay Area's greenhouse gas emissions, in Board of Directors Resolution 2013-11.

To achieve these emission reduction goals, the California legislature directed the California Air Resources Board (CARB) to develop a Scoping Plan setting forth regulatory measures that CARB will implement, along with other measures, to reduce the state's greenhouse gas emissions. One of the principal regulatory measures is CARB's Cap and Trade program, which requires industrial greenhouse gas sources to obtain "allowances" equal to their greenhouse gas emissions. The amount of available allowances is subject to a "cap" on total emissions statewide, which CARB will reduce each year. Regulated facilities will either have to reduce their emissions or purchase allowances on the open market, which will give them a financial incentive to reduce emissions and will ensure that total annual emissions from the industrial sector will not exceed the declining statewide cap.

California has also adopted the "Renewable Portfolio Standard" for electric power generation, which requires that at least 33 percent of the state's electric power must come from renewable sources by 2020, and at least 50 percent must come from renewables by 2030. To complement these efforts on electricity generation, the state has also committed to increasing the energy efficiency of existing buildings by 50 percent by 2050 in order to reduce energy demand.

California has adopted regulatory measures aimed at reducing greenhouse gas emissions from mobile sources. These measures include standards for motor vehicle emissions and the state's Low Carbon Fuel Standard, which set limits on the carbon intensity of transportation fuels. California has also adopted SB 375, the Sustainable Communities and Climate Protection Act of 2008, which requires regional transportation and land use planning agencies to develop coordinated plans, called "Sustainable Communities Strategies," to reduce greenhouse gas emissions from the transportation sector by promoting denser development and alternatives to driving. The current Sustainable Communities Strategy for the Bay Area is *Plan Bay Area 2040*, which was adopted by the Metropolitan Transportation Commission and the Association of Bay Area Governments in July of 2017.

The Air District has committed to reducing the Bay Area's regional greenhouse gas emissions to 80 percent below 1990 levels by 2050, as noted above. The Air District has also committed to a broad suite of specific measures to address greenhouse gases in the 2017 Clean Air Plan, *Spare the Air, Cool the Climate*. That document lays out the Air District's vision for what the Bay Area may look like in a post-carbon year 2050 and describes policies and actions that the region needs to take in the near- to mid-term to achieves these goals.

Significance Criteria

CEQA Guidelines section 15064.4, promulgated in 2010, sets out the procedures for determining the significance of a project's greenhouse gas emissions. In making that determination, subdivision (b)(3) of that section allows a lead agency to consider "[t]he extent to which the project complies with regulations or requirements adopted to implement a statewide, regional, or local plan for the reduction or mitigation of greenhouse gas emissions."

In 2011, California Air Resources Board promulgated the regulations establishing the Cap and Trade Program (Cal. Code Regs., tit. 17, §§ 95801–96022) to reduce greenhouse gas emissions under the California Global Warming Solutions Act of 2006. The Cap and Trade Program seeks to reduce emissions of greenhouse gases from the subject sources by applying an aggregate greenhouse gas allowance budget on covered entities and providing a trading mechanism for greenhouse gas emission allowances or offsets. (Cal. Code Regs., tit. 17, § 95801.) Cap and Trade constitutes a "plan for the reduction . . . of greenhouse gas emissions" within the meaning of Guidelines section 15064.4, subdivision (b)(3), and that section therefore authorizes agencies to determine a project's greenhouse gas emissions will have a less than significant effect on the environment based on the project's compliance with the Cap and Trade Program. (Association of Irritated Residents v. Kern County Bd. of Supervisors (2017) 17 Cal. App. 5th 708, 743.)

Discussion of Impacts

VII. a). While the primary purpose of implementing expedited BARCT requirements is to reduce emissions of ROG, NOx, SO_2, and PM, some types of control equipment have the potential to create secondary adverse air quality impacts and generate GHG emissions, through construction activities or through the addition of air pollution control equipment. The proposed BARCT requirements may result in the installation of new equipment at facilities that need to comply with the new requirements.

Limited construction activities may be required for some BARCT measures to enclose open fugitive components, install new catalyst, increase lime injection, and so forth. Construction emissions associated with this type of construction would be minor and would involve the transport of the new equipment which is expected to require one to two truck trips per project. Installation of the equipment would be expected to be limited to two to ten workers and would not require any major construction equipment and no site preparation activities are expected to be required. Therefore, retrofitting this type of existing equipment would result in minor construction emissions.

Construction activities would also be required for the construction of new air pollution control equipment at existing facilities, including vapor combustors, wet gas scrubbers, ESPs, vapor recovery systems, and SCRs. Some of the BARCT equipment would be required at existing facilities with large emission sources, e.g., refinery FCCUs. Construction activities for these types of new air pollution control equipment would be temporary. Each of the sources that might be subject to the BARCT requirements set out in the expedited schedule is subject to the Cap and Trade Program and its greenhouse gas emissions are required to comply with the requirements of the Cap and Trade Program. As a result, the greenhouse gas emissions resulting from the implementation of the expedited BARCT schedule will be less than significant.

VII. b). The facilities affected by the expedited BARCT requirements could require the installation of additional air pollution control equipment or the implementation of new measures to control criteria pollutants. These measures could generate additional GHG emissions. However, the facilities subject to expedited BARCT must comply with the Cap and Trade Program, an obligation the implementation of the expedited BARCT schedule will not change. The GHG emissions resulting from the implementation of the BARCT schedule will therefore have a less-than-significant impact.

Conclusion

Based upon the above considerations, significant adverse impacts related to greenhouse gas emissions and climate change are not expected to occur due to implementation of the expedited BARCT requirements and, therefore, will not be further evaluated in the Draft EIR.

	Potentially Significant Impact	Less Than Significant Impact With Mitigation Incorporated	Less Than Significant Impact	No Impact
VIII. HAZARDS AND HAZARDOUS MATERIALS. Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☑	☐	☐	☐
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☑	☐	☐	☐
c) Emit hazardous emissions or involve handling hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☑	☐	☐	☐
d) Be located on a site that is included on a list of hazardous materials sites compiled pursuant to Government Code §65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☐	☐	☐	☑
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, and result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☑
f) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?	☐	☐	☐	☑
g) Expose people or structures to a significant risk of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?	☐	☐	☐	☑
h) Significantly increased fire hazard in areas with flammable materials?	☐	☐	☐	☑

Setting

The Air District covers all of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, and Santa Clara Counties, and potions of western Solano and southern Sonoma Counties. Because the area of coverage is vast (approximately 5,600 square miles), land uses vary greatly and include commercial, industrial, residential, and agricultural uses.

Facilities and operations within the District handle and process substantial quantities of flammable materials and acutely toxic substances. Accidents involving these substances can result in worker or public exposure to fire, heat, blast from an explosion, or airborne exposure to hazardous substances. The potential hazards associated with handling such materials are a function of the materials being processed, processing systems, and procedures used to operate and maintain the facilities where they exist. The hazards that are likely to exist are identified by the physical and chemical properties of the materials being handled and their process conditions, including the following events.

- **Toxic gas clouds:** Toxic gas clouds are releases of volatile chemicals (e.g., anhydrous ammonia, chlorine, and hydrogen sulfide) that could form a cloud and migrate off-site, thus exposing the public. "Worst-case" conditions tend to arise when very low wind speeds coincide with an accidental release, which can allow the chemicals to accumulate rather than disperse.

- **Torch fires (gas and liquefied gas releases), flash fires (liquefied gas releases), pool fires, and vapor cloud explosions (gas and liquefied gas releases):** The rupture of a storage tank or vessel containing a flammable gaseous material (like propane), without immediate ignition, can result in a vapor cloud explosion. The "worst-case" upset would be a release that produces a large aerosol cloud with flammable properties. If the flammable cloud does not ignite after dispersion, the cloud would simply dissipate. If the flammable cloud were to ignite during the release, a flash fire or vapor cloud explosion could occur. If the flammable cloud were to ignite immediately upon release, a torch fire would ensue.

- **Thermal Radiation:** Thermal radiation is the heat generated by a fire and the potential impacts associated with exposure. Exposure to thermal radiation would result in burns, the severity of which would depend on the intensity of the fire, the duration of exposure, and the distance of an individual to the fire.

- **Explosion/Overpressure:** Process vessels containing flammable explosive vapors and potential ignition sources are present at many types of industrial facilities. Explosions may occur if the flammable/explosive vapors come into contact with an ignition source. An explosion could cause impacts to individuals and structures in the area due to overpressure.

For all affected facilities, risks to the public are reduced if there is a buffer zone between industrial processes and residences or other sensitive land uses, or the prevailing wind blows away from residential areas and other sensitive land uses. The risks posed by operations at each facility are unique and determined by a variety of factors. The facilities affected by the proposed new rules are located in industrial areas.

Regulatory Background

There are many federal and state rules and regulations that facilities handling hazardous materials must comply with which serve to minimize the potential impacts associated with hazards at these facilities.

Under the Occupational Safety and Health Administration (OSHA) regulations [29 Code of Federal Regulations (CFR) Part 1910], facilities which use, store, manufacture, handle, process, or move highly hazardous materials must prepare a fire prevention plan. In addition, 29 CFR Part 1910.119, Process Safety Management (PSM) of Highly Hazardous Chemicals, and Title 8 of the California Code of Regulations, General Industry Safety Order §5189, specify required prevention program elements to protect workers at facilities that handle toxic, flammable, reactive, or explosive materials.

Section 112 (r) of the Clean Air Act Amendments of 1990 [42 U.S.C. 7401 et. Seq.] and Article 2, Chapter 6.95 of the California Health and Safety Code require facilities that handle listed regulated substances to develop Risk Management Programs (RMPs) to prevent accidental releases of these substances, U.S. EPA regulations are set forth in 40 CFR Part 68. In California, the California Accidental Release Prevention (CalARP) Program regulation (CCR Title 19, Division 2, Chapter 4.5) was issued by the Governor's Office of Emergency Services (OES). RMPs are documents prepared by the owner or operator of a stationary source containing detailed information including: (1) regulated substances held onsite at the stationary source; (2) offsite consequences of an accidental release of a regulated substance; (3) the accident history at the stationary source; (4) the emergency response program for the stationary source; (5) coordination with local emergency responders; (6) hazard review or process hazard analysis; (7) operating procedures at the stationary source; (8) training of the stationary source's personnel; (9) maintenance and mechanical integrity of the stationary source's physical plant; and (10) incident investigation. California proposed modifications to the CalARP Program along with the state's PSM program in response to an accident at the Chevron Richmond Refinery. The proposed regulations were released for public comment on July 15, 2016 and the public comment period closed on September 15, 2016. After the close of the comment period a modified version of the proposed regulations was released in February 2017 and the public comment period for comments on the modifications closed on March 30, 2017. The final document was then filed with the Secretary of State in July 2017 and has gone into effect as of October 1, 2017.

Affected facilities that store materials are required to have a Spill Prevention Control and Countermeasures (SPCC) Plan per the requirements of 40 Code of Federal Regulations, Section 112. The SPCC is designed to prevent spills from on-site facilities and includes requirements for secondary containment, provides emergency response procedures, establishes training requirements, and so forth.

The Hazardous Materials Transportation (HMT) Act is the federal legislation that regulates transportation of hazardous materials. The primary regulatory authorities are the U.S. Department of Transportation, the Federal Highway Administration, and the Federal Railroad Administration. The HMT Act requires that carriers report accidental releases of hazardous materials to the Department of Transportation at the earliest practical moment (49 CFR Subchapter C). The California Department of Transportation (Caltrans) sets standards for trucks in California. The regulations are enforced by the California Highway Patrol.

California Assembly Bill 2185 requires local agencies to regulate the storage and handling of hazardous materials and requires development of a business plan to mitigate the release of hazardous materials. Businesses that handle any of the specified hazardous materials must submit to government agencies (i.e., fire departments), an inventory of the hazardous materials, an emergency response plan, and an employee training program. The information in the business plan can then be used in the event of an emergency to determine the appropriate response action, the need for public notification, and the need for evacuation.

Significance Criteria

The proposed project impacts associated with hazards will be considered significant if any of the following occur:

- Non-compliance with any applicable design code or regulation.
- Non-conformance to National Fire Protection Association standards.
- Non-conformance to regulations or generally accepted industry practices related to operating policy and procedures concerning the design, construction, security, leak detection, spill containment or fire protection.
- Exposure to hazardous chemicals in concentrations equal to or greater than the Emergency Response Planning Guideline (ERPG) 2 levels.

Discussion of Impacts

VIII a, b, and c. The expedited BARCT implementation schedule would require certain industrial facilities, including refineries, manufacturing, bulk storage and transfer operations, cement plants, and petroleum coke calciners, to reduce criteria pollutant emissions. These facilities may need to install additional air pollution control equipment, including domes on storage tanks, enclosures on fugitive emission sources, wet gas scrubbers, wet ESPs, SCRs, and LoTOx equipment.

Physical modifications at facilities due to installation of BARCT are expected to be limited to industrial facilities. SCRs could potentially be installed to control NOx emissions. Installation of new SCR equipment would be expected to increase the amount of ammonia used for NOx control. SCRs would require the additional delivery of ammonia or urea to the facilities where they are installed. Ammonia is a hazardous material that can be released in liquid or gaseous form. Additional catalysts could be required for SCR units and sulfur reducing catalyst additives may be required for SO_2 control. Alkaline may be required for alkaline and lime injection systems. The potential increase in the storage, transport and use of ammonia, catalysts, catalyst additives, and alkaline materials could result in significant hazard impacts which will be further evaluated in the Draft EIR.

Hazards associated with ESPs include fire and explosion hazards that can occur at the inlet to ESPs when highly charged dust particles are transported by a gas carrier that can contain the mixtures of both incombustible and combustible flue gases. The risk of ignition and even explosion is especially high in the presence of an explosive mixture of oxygen, hydrocarbons, carbon monoxide, etc. The ignition source is typically caused by the breakdown between the corona electrode and the collecting electrode, but in some cases electrostatic discharge (typically back corona) can also act as an ignition source, which may contribute to a fire or explosion.

Health and Safety Code §25506 specifically requires all businesses handling hazardous materials to submit a business emergency response plan to assist local administering agencies in an emergency release or threatened release of a hazardous material. Business emergency response plans generally require the following:

- Types of hazardous materials used and their locations;
- Training programs for employees including safe handling of hazardous materials and emergency response procedures and resources;
- Procedures for emergency response notification;
- Proper use of emergency equipment;
- Procedures to mitigate a release or threatened release of hazardous materials and measures to minimize potential harm or damage to individuals, property, or the environment; and
- Evacuation plans and procedures.

Hazardous materials at existing facilities would continue to be used in compliance with established by the California Occupational Safety and Health Administration (Cal-OSHA) regulations and procedures, including providing adequate ventilation, using recommended personal protective equipment and clothing, posting appropriate signs and warnings, and providing adequate worker health and safety training. The exposure of employees is regulated by Cal-OSHA in Title 8 of the CCR. Specifically, 8 CCR 5155 establishes permissible exposure levels (PELs) and short-term exposure levels (STELs) for various chemicals. These requirements apply to all employees. The PELs and STELs establish levels below which no adverse health effects are expected. These requirements protect the health and safety of the workers, as well as the nearby population including sensitive receptors.

In general, all local jurisdictions and all facilities using a minimum amount of hazardous materials are required to formulate detailed contingency plans to eliminate, or at least minimize, the possibility and effect of fires, explosion, or spills. In conjunction with the California Office of Emergency Services, local jurisdictions have enacted ordinances that set standards for area and business emergency response plans. These requirements include immediate notification, mitigation of an actual or threatened release of a hazardous material, and evacuation of the emergency area.

The above regulations provide comprehensive measures to reduce hazards of explosive or otherwise hazardous materials. Compliance with these and other federal, state and local regulations and proper operation and maintenance of equipment should ensure the potential for explosions or accidental releases of hazardous materials is not significant.

Despite the measures listed above, a malfunction or accident when using add-on pollution control equipment could potentially expose people to hazardous materials, explosions, or fires. The transport, use, and storage of additional hazardous materials may result in a release in the event of an accident. As a result, hazard impacts related to hazards to the public, schools, or the environment will be further evaluated in the Draft EIR.

VIII d. Government Code §65962.5 requires creation of lists of facilities that may be subject to Resource Conservation and Recovery Act (RCRA) permits or site cleanup activities. Most of the refineries affected by the expedited BARCT requirements are included on the hazardous materials sites list pursuant to Government Code §65962.5. It would be expected that other industrial facilities affected by the BARCT requirements would also be on the list. The facilities affected by the proposed BARCT requirements would be required to continue to manage any and all hazardous materials in accordance with federal, state, and local regulations. Implementing BARCT requirements are not expected to interfere with site cleanup activities or create additional site contamination. As a result, the proposed project is not expected to affect any facilities included on a list of hazardous material sites and, therefore, would not create a significant hazard to the public or environment.

VIII e-f. The proposed project is not expected to result in a safety hazard for people residing or working within two miles of a public airport or air strip. No impacts on airports or airport land use plans are anticipated from the proposed expedited BARCT requirements. Modifications to industrial facilities to install BARCT would be confined to the existing industrial area and would not be expected to interfere with airport activities. The hazards associated with the potential use of additional hazardous materials will be evaluated in the Draft EIR as discussed above.

VIII g-h. No increase in hazards associated with wildfires is anticipated from implementation of expedited BARCT. Affected facilities already exist and operate within the confines of existing industrial facilities. Native vegetation has been removed from the operating portions of the affected facilities to minimize fire hazards. The proposed project would not increase the existing risk of fire hazards in areas with flammable brush, grass, or trees, nor would it increase fire risk by increasing the use of flammable materials. It is expected that facilities adjacent to wildland areas take appropriate and required actions to protect their property from wildland fires. The proposed project requirements are not expected to expose people or structures to wild fires. Therefore, no significant increase in fire hazards is expected due to the proposed expedited BARCT requirements.

Conclusion

Implementation of the expedited BARCT requirements would reduce criteria pollutant emissions from industrial facilities throughout the Bay Area. However, construction and operation of new air pollution control equipment have the potential to result in an increase in the storage, transport and use of hazardous materials in the Bay Area and will be evaluated in the Draft EIR. No significant impacts were identified for sites included on a list of hazardous materials sites compiled pursuant to Government Code §65962.5, projects located within or adjacent to airports or airport land use plans, emergency response plans, wildland fires, and hazards associated with flammable materials and these topics will not be addressed further in the Draft EIR.

	Potentially Significant Impact	Less Than Significant Impact With Mitigation Incorporated	Less Than Significant Impact	No Impact
IX. HYDROLOGY AND WATER QUALITY.				
Would the project:				
a) Violate any water quality standards or waste discharge requirements?	☑	☐	☐	☐
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g. the production rate of pre-existing nearby wells would drop to a level that would not support existing land uses or planned uses for which permits have been granted)?	☑	☐	☐	☐
c) Substantially alter the existing drainage pattern of the site or area, including through alteration of the course of a stream or river, in a manner that would result in substantial erosion or siltation on- or off-site?	☐	☐	☐	☑
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner that would result in flooding onsite or offsite?	☐	☐	☐	☑
e) Create or contribute runoff water that would exceed the capacity of existing or planned storm water drainage systems or provide substantial additional sources of polluted runoff?	☐	☐	☑	☐
f) Otherwise substantially degrade water quality?	☑	☐	☐	☐
g) Place housing within a 100-year flood hazard area, as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	☐	☐	☐	☑
h) Place within a 100-year flood hazard area structures that would impede or redirect flood flows?	☐	☐	☐	☑

i)	Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?	☐	☐	☐	☑
j)	Inundation by seiche, tsunami, or mudflow?	☐	☐	☐	☑

Setting

The Air District covers all of Alameda, Contra Costa, Marin, San Francisco, San Mateo, Santa Clara, and Napa Counties and portions of southwestern Solano and southern Sonoma Counties. The area of coverage is vast (about 5,600 square miles). Reservoirs and drainage streams are located throughout the area within the Air District's jurisdiction, and discharge into the Bays. Marshlands incised with numerous winding tidal channels containing brackish water are located throughout the Bay Area.

The San Francisco Bay estuary system is one of the largest in the country and drains approximately 40 percent of California. Water from the Sacramento and San Joaquin Rivers of the Central Valley flow into what is known as the Delta region, then into the sub-bays, Suisun Bay and San Pablo Bay, and finally into the Central Bay and out the Golden Gate strait. The Delta is a large triangle of interconnected sloughs and agricultural "islands" that forms a key link in California's water delivery system. Some of the fresh water flows through the Delta and into Bay, but much is diverted from the Bay for agricultural, residential, and industrial purposes, as well as delivery to distant cities of southern California as part of state and federal water projects (ABAG, 2017).

The two major drainages, the Sacramento and San Joaquin Rivers receive more than 90 percent of runoff during the winter and spring months from rainstorms and snow melt. San Francisco Bay encompasses approximately 1,600 square miles and is surrounded by the nine Bay Area counties of which seven border the Bay. Other surface waters flow either directly to the Bay or Pacific Ocean. The drainage basin that contributes surface water flows directly to the Bay covers a total area of 3,464 square miles. The largest watersheds include Alameda Creek (695 square miles), the Napa River (417 square miles), and Coyote Creek (353 square miles) watersheds. The San Francisco Bay estuary includes deep-water channels, tidelands, and marshlands that provide a variety of habitats for plants and animals. The salinity of the water varies widely as the landward flows of saline water and the seaward flows of fresh water converge near the Benicia Bridge. The salinity levels in the Central Bay can vary from near oceanic levels to one quarter as much, depending on the volume of freshwater runoff (ABAG 2017).

Surface waters in the Bay Area include freshwater rivers and streams, coastal waters, and estuarine waters. Estuarine waters include the San Francisco Bay Delta from the Golden Gate Bridge to the Sacramento and San Joaquin Rivers, and the lower reaches of various streams that flow directly into the Bay, such as the Napa and Petaluma Rivers in the North Bay and the Coyote and San Francisquito Creeks in the South Bay (ABAG, 2017).

The Bay Area region is divided into a total of 28 groundwater basins. The ten primary groundwater basins in the Bay Area are the Petaluma Valley, Napa-Sonoma Valley, Suisun-Fairfield Valley, San Joaquin Valley, Clayton Valley, Diablo Valley, San Ramon Valley, Livermore Valley, Sunol Valley, and Santa Clara Valley basins. Groundwater in the region is used for numerous purposes, including municipal and industrial water supply. However, groundwater use accounts for only about five percent of the total water usage (ABAG, 2017).

Together, surface water and ground water supply approximately 31 percent of Bay Area water. Surface water from local rivers and streams (including the Delta) is an important source for all Bay Area Water agencies, but particularly in the North Bay counties, where access to imported water is more limited because of infrastructure limitations. The greatest proportion of Bay Area water is imported from Sierra Nevada and Delta sources, comprising approximately 66 percent of supply. The primary Sierra Nevada sources are the Mokelumne River and Tuolumne River watersheds. Several Bay Area water agencies receive Delta water through the State and Central Valley Water Projects, which comprise a vast network of canals and aqueducts for the delivery of water throughout the Bay Area and the Central Valley (ABAG, 2017).

Recycled water in the Bay Area has come to be widely used for a number of applications, including landscape irrigation, agricultural uses, commercial and industrial purposes, and as a supply to the area's wetlands. The Alameda County Water District operates the Newark Desalination Facility which supplies approximately 12.5 million gallons per day to the distribution system (ABAG, 2017).

Wastewater treatment in the Bay Area is provided by various agencies as well as individual city and towns wastewater treatment systems. Some treatment plants serve individual cities while others serve multiple jurisdictions. More than 50 agencies provide wastewater treatment throughout the Bay Area. Most industrial facilities have wastewater and storm water treatment facilities and discharge treated wastewater under the requirements of National Pollutant Discharge Elimination System (NPDES) permits.

Regulatory Background

The Federal Clean Water Act of 1972 primarily establishes regulations for pollutant discharges into surface waters in order to protect and maintain the quality and integrity of the nation's waters. This Act requires industries that discharge wastewater to municipal sewer systems to meet pretreatment standards. The regulations authorize the U.S. EPA to set the pretreatment standards. The regulations also allow the local treatment plants to set more stringent wastewater discharge requirements, if necessary, to meet local conditions.

The 1987 amendments to the Clean Water Act enabled the U.S. EPA to regulate, under the NPDES program, discharges from industries and large municipal sewer systems. The U.S. EPA set initial permit application requirements in 1990. The State of California, through the State Water Resources Control Board, has authority to issue NPDES permits, which meet U.S. EPA requirements, to specified industries.

The Porter-Cologne Water Quality Act is California's primary water quality control law. It implements the state's responsibilities under the Federal Clean Water Act but also establishes state wastewater discharge requirements. The Regional Water Quality Control Boards administer the state requirements as specified under the Porter-Cologne Water Quality Act, which include storm water discharge permits. The water quality in the Bay Area is under the jurisdiction of the San Francisco Bay Regional Water Quality Control Board.

In response to the Federal Act, the State Water Resources Control Board prepared two statewide plans in 1991 and 1995 that address storm water runoff: the California Inland Surface Waters Plan and the California Enclosed Bays and Estuaries Plan, which have been updated in 2005 as the Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California. Enclosed bays are indentations along the coast that enclose an area of oceanic water within distinct headlands or harbor works. San Francisco Bay, and its constituent parts, including Carquinez Strait and Suisun Bay, fall under this category.

The San Francisco Bay Basin Plan identifies the: (1) beneficial water uses that need to be protected; (2) the water quality objectives needed to protect the designated beneficial water uses; and (3) strategies and time schedules for achieving the water quality objectives. The beneficial uses of the Carquinez Strait that must be protected which include water contact and non-contact recreation, navigation, ocean commercial and sport fishing, wildlife habitat, estuarine habitat, fish spawning and migration, industrial process and service supply, and preservation of rare and endangered species. The Carquinez Strait and Suisun Bay are included on the California list as impaired water bodies due to the presence of chlordane, copper, DDT, diazinon, dieldrin, dioxin and furan compounds, mercury, nickel, PCBs, and selenium.

Significance Criteria

Water Demand:

- The existing water supply does not have the capacity to meet the increased demands of the project, or the project would use more than 263,000 gallons per day of potable water.

Water Quality:

- The project will cause degradation or depletion of ground water resources substantially affecting current or future uses.
- The project will cause the degradation of surface water substantially affecting current or future uses.
- The project will result in a violation of National Pollutant Discharge Elimination System (NPDES) permit requirements.
- The capacities of existing or proposed wastewater treatment facilities and the sanitary sewer system are not sufficient to meet the needs of the project.
- The project results in substantial increases in the area of impervious surfaces, such that interference with groundwater recharge efforts occurs.
- The project results in alterations to the course or flow of floodwaters.

Discussion of Impacts

IX a, b, and f. The expedited BARCT implementation schedule would require certain industrial facilities including refineries, manufacturing, bulk storage and transfer operations, cement plants, and petroleum coke calciners to reduce criteria pollutant emissions. These facilities may need to install additional air pollution control equipment, including domes on storage tanks, enclosures on fugitive emission sources, wet gas scrubbers, wet ESPs, SCRs, and LoTOx equipment.

Physical modifications at facilities due to installation of BARCT are expected to be limited to industrial facilities. Construction activities for new air pollution control equipment could be substantial for large facilities, e.g., FCCUs at refineries. However, construction activities would occur within the confines of existing industrial facilities that have already been graded and developed. While water may be used for dust suppression, substantial earthmoving would not be required. Therefore, significant water use would not be associated with construction activities.

The operation of some types of air pollution control equipment does not require the use of water or generate wastewater discharge, for example SCRs do not require the use of water and are not expected to result in any increase in wastewater. However, the use of wet gas scrubbers and wet ESPs do require additional water use. The proposed project would be considered significant if it exceeded the CEQA threshold of 263,000 gallons or more of potable water per day. Wet gas scrubbers on a refinery FCCU can require substantial water use in excess of 263,000 gallons per day and would result in additional wastewater discharge. Therefore, the potential impacts of water use and wastewater discharge will be evaluated in the Draft EIR.

VIII c, d, and e. Compliance with expedited BARCT requirements is expected to be limited to the installation of air pollution control equipment and modifications to industrial facilities. All activities associated with the proposed project are expected to occur within the confines of existing industrial facilities. The proposed project does not have the potential to substantially increase the area subject to runoff since the construction activities are expected to be limited in size and would be located within the confines of existing industrial facilities that have already been graded. In addition, storm water drainage within the facilities is currently controlled and construction activities are not expected to alter the storm water drainage within these facilities. Therefore, the BARCT measures are not expected to substantially alter the existing drainage or drainage patterns, result in erosion or siltation, alter the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner that would result in flooding onsite or offsite. Additionally, the proposed project is not expected to create or contribute runoff water that would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of contaminated runoff. Therefore, no significant adverse impacts to storm water runoff are expected as a result of the proposed project.

VIII g, h, i, and j. The proposed project does not include the construction of new or relocation of existing housing or other types of facilities and, as such, would not require the placement of housing or other structures within a 100-year flood hazard area. (See also XIII “Population and Housing”). The facilities affected by BARCT are industrial facilities. Any new construction associated with the proposed project is expected to occur within the confines of existing industrial facilities. As a result, the proposed project would not be expected to create or substantially increase risks from flooding; expose people or structures to significant risk of loss, injury or death involving flooding; or increase existing risks, if any, of inundation by seiche, tsunami, or mudflow.

Conclusion

Implementation of the expedited BARCT requirements would reduce criteria pollutant emissions from industrial facilities throughout the Bay Area. However, construction and operation of new air pollution control equipment has the potential to result in an increase in water use and wastewater discharge associated with new air pollution control equipment and will be evaluated in the Draft EIR. No significant impacts were identified for storm water runoff and drainage, flood hazards, or the risks of inundation by seiche, tsunami or mudflow and these topics will not be addressed further in the Draft EIR.

		Potentially Significant Impact	Less Than Significant Impact With Mitigation Incorporated	Less Than Significant Impact	No Impact
X.	**LAND USE AND PLANNING.** Would the project:				
a)	Physically divide an established community?	☐	☐	☐	☑
b)	Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to a general plan, specific plan, local coastal program or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	☐	☐	☐	☑
c)	Conflict with any applicable habitat conservation plan or natural community conservation plan?	☐	☐	☐	☑

Setting

The Air District covers all of Alameda, Contra Costa, Marin, San Francisco, San Mateo, Santa Clara, and Napa Counties and portions of southwestern Solano and southern Sonoma Counties. The area of coverage is vast (about 5,600 square miles), so that land uses vary greatly and include commercial, industrial, residential, agricultural, and open space uses. The land uses surrounding the Bay margins tend to be more intensely developed, particularly from San Francisco south along the Peninsula to Santa Clara County, and Contra Costa County south through Alameda County to Santa Clara County. These areas also include extensive networks of open space. The counties north of the Bay (Marin, Sonoma, and Napa) are more sparsely developed with a combination of suburban development, smaller cities and towns, and agriculture defining the landscape. Other areas of the Bay Area, such as the East Bay and Solano County, tend to be more suburban in character, with heavy industry related to oil refineries dotting the landscape as well as agriculture (ABAG, 2017).

Approximately 18 percent of the region's 4.8 million acres are considered to be urban or built-up land according to the California Farmland Mapping and Monitoring Program. The remaining undeveloped area includes open space and agricultural lands as well as water bodies and parks. Approximately 29 percent of the region is identified as protected open space. The Bay Area includes 101 cities, with San Jose, San Francisco, and Oakland representing the largest urbanized centers (ABAG, 2017).

Regulatory Background

Land uses are generally protected and regulated by the City and/or County General Plans through land use and zoning requirements.

Significance Criteria

The proposed project impacts will be considered significant on land use and planning if the project conflicts with the land use and zoning designations established by local jurisdictions, or any applicable habitat conservation or natural community conservation plan.

Discussion of Impacts

X a-c. The expedited BARCT implementation schedule would require certain industrial facilities including refineries, manufacturing, bulk storage and transfer operations, cement plants, and petroleum coke calciners to reduce criteria pollutant emissions. These facilities may need to install additional air pollution control equipment, including domes on storage tanks, enclosures on fugitive emission sources, wet gas scrubbers, wet ESPs, SCRs, and LoTOx equipment.

Physical modifications at facilities due to installation of BARCT are expected to be limited to industrial facilities. Construction activities for new air pollution control equipment could be substantial for large facilities, e.g., FCCUs at refineries. However, construction activities would occur within the confines of existing industrial facilities that have already been graded and developed. Thus, the proposed project is not expected to have impacts to non-industrial land uses and would not result in impacts that would physically divide an established community.

The General Plans and land use plans for areas with industrial land uses, generally allow for and encourage the continued use of industrial areas within their respective communities. Some of the General Plans encourage the modernization of existing industrial areas, including refineries (Benicia, 2015 and Santa Clara, 2011). The construction of equipment within the confines of existing facilities is not expected to conflict with any applicable land use plan, policy or regulation of an agency with jurisdiction over the facilities that would be required to implement BARCT. The jurisdictions with land use approval recognize and support the continued use of industrial facilities. The construction required to comply with BARCT requirements that would be imposed by the proposed project would not interfere with those land use policies or objectives.

The proposed project has no components which would affect land use plans, policies, or regulations. Regulating emissions from existing facilities, will not require local governments to alter land use and other planning considerations. Habitat conservation or natural community conservation plans, agricultural resources or operations would not be affected by the proposed project, and divisions of existing communities would not occur. Therefore, current or planned land uses within the District will not be significantly affected as a result of the proposed project.

Conclusion

Based upon the above considerations, significant adverse project-specific impacts to land use and planning are not expected to occur due to implementation of the expedited BARCT requirements and, therefore, will not be further evaluated in the Draft EIR.

	Potentially Significant Impact	Less Than Significant Impact With Mitigation Incorporated	Less Than Significant Impact	No Impact
XI. MINERAL RESOURCES. Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☐	☐	☑
b) Result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan?	☐	☐	☐	☑

Setting

The Air District covers all of Alameda, Contra Costa, Marin, San Francisco, San Mateo, Santa Clara, and Napa Counties and portions of southwestern Solano and southern Sonoma Counties. The area of coverage is vast (about 5,600 square miles), so that land uses vary greatly and include commercial, industrial, residential, agricultural, and open space uses.

Regulatory Background

Mineral resources are generally protected and regulated by the City and/or County General Plans through land use and zoning requirements.

Significance Criteria

The proposed project impacts on mineral resources will be considered significant if:

- The project would result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state.
- The proposed project results in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan.

Discussion of Impacts

XI a-b. The expedited BARCT implementation schedule would require certain industrial facilities including refineries, manufacturing, bulk storage and transfer operations, cement plants, and petroleum coke calciners to reduce criteria pollutant emissions. These facilities may need to install additional air pollution control equipment, including domes on storage tanks, enclosures on fugitive emission sources, wet gas scrubbers, wet ESPs, SCRs, and LoTOx equipment.

Physical modifications at facilities due to installation of BARCT are expected to be limited to industrial facilities. Construction activities would occur within the confines of existing industrial facilities that have already been graded and developed. Construction of air pollution control equipment and modifications to existing industrial facilities as a result of the proposed project is not expected to affect mineral resources. Construction and operation of new equipment associated with proposed project is not expected to require mineral resources that are of value to the region or result in the loss of a locally important mineral resource site. Thus, no significant adverse impacts to mineral resources are expected.

Conclusion

Based upon the above considerations, significant adverse project-specific impacts to mineral resources are not expected to occur due to implementation of the expedited BARCT requirements and, therefore, will not be further evaluated in the Draft EIR.

	Potentially Significant Impact	Less Than Significant Impact With Mitigation Incorporated	Less Than Significant Impact	No Impact
XII. NOISE. Would the project result in:				
a) Exposure of persons to or generate noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?	☐	☐	☑	☐
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?	☐	☐	☑	☐
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☑	☐
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☑	☐
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☑
f) For a project within the vicinity of a private airstrip would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☑

Setting

The ambient noise environment in the urban areas of the Bay Area is defined by a wide variety of noise sources, with the predominant noise source being traffic. Traffic noise exposure is primarily a function of the volume of vehicles per day, the speed of those vehicles, the type of ground surface, the number of those vehicles represented by medium and heavy trucks, the distribution of those vehicles during daytime and nighttime hours, and the proximity of noise-sensitive receivers to the roadways. Existing average traffic noise exposure ranges from 52.1 decibels (dBA) (next to collector and small roads) to as high as 75.9 dBA (next to freeways). Bus transit also contributes to roadway noise levels. In San Francisco, a large portion of the transit bus fleet is electrified and, consequently, the contribution of bus transit to localized roadway noise levels is decreased (ABAG, 2013).

The Bay Area is also presently affected by noise from freight and passenger rail operations. While these operations generate significant noise levels in the immediate vicinity of the railways, train operations are intermittent and area railways are widely dispersed. Commuter rail such as San Francisco Muni Metro and Santa Clara Valley Transportation Authority (VTA) operate with more frequency than standard gauge rail operations but lower speeds resulting in lower noise levels. Bay Area Rapid Transit (BART) operations, on the other hand, can attain higher speeds and have the potential for greater noise levels along extended stretches. Noise levels from rail operations in the Bay Area can range from 70 dBA to 82 dBA, Community Noise Equivalent Level (CNEL). Train operations may be a source of ground vibration near the tracks. (ABAG, 2017).

The Bay Area is home to many airports—including public use, private use, and military facilities. Major airports include San Francisco International, Oakland International and Norman Y. Mineta San José International. In addition to the numerous daily aircraft operations originating and terminating at these facilities, aircraft not utilizing these airports frequently fly over the Bay Area. All of these operations contribute to the overall ambient noise environment. In general, like rail noise, the proximity of the receiver to the airport and aircraft flight path determines the noise exposure. Other contributing factors include the type of aircraft operated, altitude of the aircraft, and atmospheric conditions. Atmospheric conditions may contribute to the direction of aircraft operations (flow) and affect aircraft noise propagation (ABAG, 2017).

Based on the adopted Airport Land Use Compatibility Plan (ALUCP) for San Francisco International Airport, the 65 dBA CNEL contour extends approximately 6 miles northwest of the airport. Based on the ALUCP for Oakland International Airport, the 65 dBA CNEL contour extends approximately 5 miles south of the airport. Based on the ALUCP for Mineta San Jose International Airport, the 65 dBA CNEL contour extends approximately 2.5 miles northwest from the airport. Many other smaller airports and airstrips exist within the Bay Area where widely varying noise levels contribute to the existing noise environment (ABAG, 2017).

A wide variety of industrial and other non-transportation noise sources are located within the Bay Area. These include manufacturing plants, landfills, treatment plants (e.g., water), power generation facilities, food packaging plants, lumber mills, and aggregate mining facilities, just to name a few. Noise generated by these sources varies widely, but in many cases may be a significant, if not dominant, contributor to the noise environment in a specific community (ABAG, 2017).

Regulatory Background

Noise levels related to construction and operation activities are addressed in local General Plan policies and local noise ordinance standards. The General Plans and noise ordinances generally establish allowable noise limits within different land uses including residential areas, other sensitive use areas (e.g., schools, churches, hospitals, and libraries), commercial areas, and industrial areas.

Significance Criteria

The proposed project impacts on noise will be considered significant if:

- Construction noise levels exceed the local noise ordinances or, if the noise ordinance is currently exceeded, project noise sources increase ambient noise levels by more than three decibels (dBA) at the site boundary.
- The proposed project operational noise levels exceed any of the local noise ordinances at the site boundary or, if the noise threshold is currently exceeded, project noise sources increase ambient noise levels by more than three dBA at the site boundary.

Discussion of Impacts

XII a, c, and d. The expedited BARCT implementation schedule would require certain industrial facilities including refineries, manufacturing, bulk storage and transfer operations, cement plants, and petroleum coke calciners to reduce criteria pollutant emissions. These facilities may need to install additional air pollution control equipment, including domes on storage tanks, enclosures on fugitive emission sources, wet gas scrubbers, wet ESPs, SCRs, and LoTOx equipment.

Physical modifications at facilities due to installation of BARCT are expected to be limited to industrial facilities. Construction activities for new air pollution control equipment could be substantial for large facilities, e.g., FCCUs at refineries. However, construction activities would occur within the confines of existing industrial facilities and adjacent to existing industrial structures. The existing noise environment at each of the affected facilities is typically dominated by noise from existing equipment onsite, vehicular traffic around the facilities, and trucks entering and exiting facility premises. Construction required for the installation of air pollution control equipment or facility modifications is not expected to significantly alter the existing noise of an industrial facility. Construction activities associated with the proposed project would generate temporary noise associated with construction equipment and construction-related traffic. Construction would likely require truck trips to deliver equipment, construction workers, and construction equipment (e.g., forklift, welders, backhoes, cranes, and generators). All construction activities would be temporary, would occur during daylight hours or within hours established under the local noise ordinance, and would occur within the confines of existing industrial facilities so that no significant increase in noise during construction activities is expected.

Air pollution control equipment is not generally a major noise source. The equipment would be located within heavy industrial areas and compatible with such uses. Further, all noise producing equipment must comply with local noise ordnances and applicable OSHA and Cal/OSHA noise requirements. Therefore, industrial operations affected by the expedited BARCT requirements are not expected to have a significant adverse effect on local noise levels or noise ordinances.

XII b. The proposed project is not expected to generate or expose people to excessive groundborne vibration or groundborne noise. The use of large construction equipment that would generate substantial noise or vibration (e.g., backhoes, graders, jackhammers, etc.) would be limited because the sites are already graded and developed. Further, construction activities are temporary and would occur during the daylight hours, in compliance with local noise standards and ordinances. Therefore, the proposed project is not expected to generate excessive groundborne vibration or noise.

XII e-f. Affected facilities would still be expected to comply, and not interfere, with any applicable airport land use plans. It is assumed that operations in these areas near airports are subject to and in compliance with existing community noise ordinances and applicable OSHA or Cal/OSHA workplace noise reduction requirements. In addition to noise generated by current operations, noise sources in each area may include nearby freeways, truck traffic to adjacent businesses, and operational noise from adjacent businesses. None of the proposed BARCT measures would locate residents or commercial buildings or other sensitive noise sources closer to airport operations. There are no components of the proposed BARCT measures that would substantially increase ambient noise levels within or adjacent to airports. Therefore, these topics will not be further evaluated in the EIR.

Conclusion

Based upon the above considerations, significant adverse project-specific impacts on noise are not expected to occur due to implementation of the expedited BARCT requirements and, therefore, will not be further evaluated in the Draft EIR.

	Potentially Significant Impact	Less Than Significant Impact with Mitigation Incorporated	Less Than Significant Impact	No Impact
XIII. POPULATION AND HOUSING. Would the project:				
a) Induce substantial population growth in an area either directly (e.g., by proposing new homes and businesses) or indirectly (e.g. through extension of roads or other infrastructure)?	☐	☐	☐	☑
b) Displace a substantial number of existing housing units, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☑
c) Displace a substantial number of people, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☑

Setting

The Air District covers all of Alameda, Contra Costa, Marin, San Francisco, San Mateo, Santa Clara, and Napa Counties and portions of southwestern Solano and southern Sonoma Counties. The area of coverage is vast (about 5,600 square miles), so that land uses vary greatly and include commercial, industrial, residential, agricultural, and open space uses. The expedited BARCT requirements would apply to facilities which are located within industrial areas of the Bay Area.

Population in the Bay Area in 2015 was about 7.6 million people, which is approximately 20 percent of California's population. The population of the Bay Area is expected to grow to about 9.6 million people by 2040. Approximately 4 million people in the Bay Area were employed in 2015, and that number is expected to grow to 4.7 million jobs by 2040. There were approximately 2.8 million households in the Bay Area in 2015, and the number of households is expected to increase to 3.4 million by 2040 (ABAG, 2017).

Regulatory Background

Population and housing growth and resources are generally protected and regulated by the City and/or County General Plans through land use and zoning requirements.

Significance Criteria

The proposed project impacts on population and housing will be considered significant if:

- The demand for temporary or permanent housing exceeds the existing supply.

- The proposed project produces additional population, housing or employment inconsistent with adopted plans either in terms of overall amount or location.

Discussion of Impacts

XIII a). According to ABAG, population in the Bay Area is currently about 7.6 million people and is expected to grow to about 9.6 million people by 2040 (ABAG, 2017). The proposed project is not anticipated to generate any significant effects, either directly or indirectly, on the Bay Area's population or population distribution. The proposed project will require construction activities to modify existing operations and/or install air pollution control equipment at existing industrial facilities. It is expected that the existing labor pool would accommodate the labor requirements for the construction of the new and modified industrial equipment. In addition, it is not expected that the affected facilities would need to hire additional personnel to operate new air pollution control equipment. In the event that 1-2 new employees are hired, the existing local labor pool in the District (over seven million people) can accommodate any increase in demand for workers that might occur as a result of adopting the expedited BARCT requirements. As such, adopting the expedited BARCT requirements is not expected to induce substantial population growth.

XIII b and c). As discussed previously, the proposed expedited BARCT requirements are designed to reduce criteria pollutant emissions from stationary sources in the Bay Area. Construction associated with the proposed project is expected to be limited to constructing new air pollution control equipment or facility modifications at industrial facilities. All construction would take place at existing industrial facilities. The implementation of the expedited BARCT requirements is not expected to result in the creation of any industry/business that would affect population growth, directly or indirectly induce the construction of single- or multiple-family units, or require the displacement of people or housing elsewhere in the Bay Area. Based upon these considerations, significant population and housing impacts are not expected from the implementation of the proposed project.

Conclusion

Based upon the above considerations, significant adverse project-specific impacts to population and housing are not expected to occur due to implementation of the expedited BARCT requirements and, therefore, will not be further evaluated in the Draft EIR.

	Potentially Significant Impact	Less Than Significant Impact With Mitigation Incorporated	Less Than Significant Impact	No Impact
XIV. PUBLIC SERVICES. Would the project:				
a. Result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities or a need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times, or other performance objectives for any of the following public services:				
Fire protection?	☐	☐	☐	☑
Police protection?	☐	☐	☐	☑
Schools?	☐	☐	☐	☑
Parks?	☐	☐	☐	☑
Other public facilities?	☐	☐	☐	☑

Setting

The Air District covers all of Alameda, Contra Costa, Marin, San Francisco, San Mateo, Santa Clara, and Napa Counties and portions of southwestern Solano and southern Sonoma Counties.

Public services are provided by a wide variety of local agencies. Fire protection services are managed at the local level, typically by municipalities, counties, fire protection districts, or volunteer fire companies. California Government Code §38611 states that any city organized under general law must establish a fire department unless it is included within the boundaries of an established fire protection district. State and federal lands are generally served by State and federal fire agencies, e.g., CALFIRE and National Park Service. In some cases, businesses and native Tribes manage their own fire departments. Each fire protection agency is responsible for serving its own prescribed area, but mutual aid agreements are in wide use across the region such that agencies can rely on assistance from neighboring agencies in the case of overwhelming demand (ABAG, 2017).

Police services are provided on the State, county, and local levels. Police services provide law enforcement in crime prevention, traffic and congestion control, safety management, emergency response, and homeland security. The California Highway Patrol (CHP) is responsible for police protection along the interstate highway systems and provides services for traffic management, emergency response, and protection of the highway system. Each county in the Bay Area has its own sheriff's department responsible for police protection in unincorporated areas of each county. Each incorporated city and town has a police department responsible for police protection within its own jurisdiction. Unincorporated areas and individual cities and towns also may contract with county sheriff departments for police services instead of providing their own (ABAG, 2017).

Although the California public school system is under the policy direction of the Legislature, the California Department of Education relies on local control for the management of school districts. School district governing boards and district administrators allocate resources among the schools of the district and set education priorities for their schools. Each jurisdiction in the Bay Area provides residents with local public education facilities and services, including elementary, middle, secondary, and post-secondary schools, as well as special and adult education. As of 2015-2016 school year, there were 2,018 public and charter schools in the Bay Area with 1,019,853 enrolled students and 51,702 teachers (ABAG, 2017).

Public facilities within the Air District are managed by different county, city, and special-use districts.

Regulatory Background

City and/or County General Plans usually contain goals and policies to assure adequate public services are maintained within the local jurisdiction.

Significance Criteria

The proposed project impacts on public services will be considered significant if the project results in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities or the need for new or physically altered government facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response time or other performance objectives.

Discussion of Impacts

XIV a. As noted in the "Population and Housing" discussion above, the proposed project is not expected to induce population growth because the existing local labor pool (e.g., workforce) is sufficient to accommodate the expected construction work force. No increase in permanent workers is expected to be required to operate the equipment associated with the expedited BARCT requirements. Therefore, there will be no increase in local population and thus no impacts are expected to local schools or parks.

The proposed project would not result in the need for new or physically altered government facilities in order to maintain acceptable service ratios, response times, or other performance objectives. The facilities affected by the proposed project are existing facilities for which public services are already required and no increase in the need for such services is expected. Furthermore, a number of industrial facilities have existing security and fire-fighting capabilities, e.g., refineries, and are able to respond to fire and security issues independent of public police and fire services. There will be no increase in population as a result of the adoption of the expedited BARCT schedule and, therefore, no need for physically altered government facilities.

Conclusion

Based upon the above considerations, significant adverse project-specific impacts on public services are not expected to occur due to implementation of the expedited BARCT requirements and, therefore, will not be further evaluated in the Draft EIR.

	Potentially Significant Impact	Less Than Significant Impact With Mitigation Incorporated	Less Than Significant Impact	No Impact
XV. RECREATION.				
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	☐	☐	☐	☑
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities that might have an adverse physical effect on the environment?	☐	☐	☐	☑

Setting

The Air District covers all of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, and Santa Clara Counties, and potions of western Solano and southern Sonoma Counties. Because the area of coverage is vast (approximately 5,600 square miles), land uses vary greatly and include commercial, industrial, residential, and agricultural uses. The Bay Area contains approximately 1.3 million acres of parks and open space areas, with Santa Clara County having the most (about 19%) followed by Sonoma County (17%), and Marin County (16%). Approximately 265,000 acres of new parkland were added to the regional's open space inventory between 2002 and 2013, representing a 26 percent increase. Additionally, approximately 200,000 acres of privately owned land are held in permanent reserve as of 2013. While access by the general public to these reserve areas is restricted, they are important for the preservation of wildlife habitats and the protection of the environment and rural characteristics of various parts of the region (ABAG, 2017).

Parks and open space are generally categorized according to their size and amenities. Smaller parks such as pocket parks, neighborhood parks, community parks, urban forests, and community gardens serve local communities, typically are located in urbanized areas, and often include a wide range of improvements from playing fields and picnic areas to playgrounds and fitness trails. These parks are most often managed by local park districts or municipalities, which typically set minimum standards for park acreage based on their population. Larger open space areas such as regional parks, greenbelts, trails and pathways, natural and wildlife preserves, state parks and federal parks serve a broader geographic range, typically are located outside of major urbanized areas, and generally include fewer improvements. Management of these parks is divided among a range of organizations and agencies including regional park districts, State and federal government, private individuals, and non-profit land trusts.

Regulatory Background

Recreational areas are generally protected and regulated by the City and/or County General Plans at the local level through land use and zoning requirements. Some parks and recreation areas are designated and protected by state and federal regulations.

Significance Criteria

The proposed project impacts on recreation will be considered significant if:

- The project results in an increased demand for neighborhood or regional parks or other recreational facilities.
- The project adversely affects existing recreational opportunities.

Discussion of Impacts

XV a-b. As discussed under "Land Use" above, there are no provisions in the expedited BARCT requirements that would affect land use plans, policies, or regulations. Land use and other planning considerations are determined by local governments; no land use or planning requirements will be altered by the proposed BARCT requirements. Construction associated with the proposed project is expected to be limited to air pollution control equipment and modifications to existing industrial facilities and would employ temporary construction workers. All construction would take place at existing facilities that have been previously graded. Further, no increase in permanent workers is expected at the facilities where BARCT would be installed. Thus, there would be no increase in population that would result in more frequent use of recreational facilities.

The proposed project would not increase or redistribute population and, therefore, would not increase the demand for or use of existing neighborhood and regional parks or other recreational facilities or require the construction of new or the expansion of existing recreational facilities. Therefore, adoption of the expedited BARCT requirements is not expected to have any significant adverse impacts on recreation.

Conclusion

Based upon the above considerations, significant adverse project-specific impacts to recreational facilities are not expected to occur due to implementation of the expedited BARCT requirements and, therefore, will not be further evaluated in the Draft EIR.

	Potentially Significant Impact	Less Than Significant Impact With Mitigation Incorporated	Less Than Significant Impact	No Impact
XVI. TRANSPORTATION/TRAFFIC. Would the project:				
a) Conflict with an applicable plan, ordinance or policy establishing measures of effectiveness for the performance of the circulation system, taking into account all modes of transportation including mass transit and non-motorized travel and relevant components of the circulation system, including but not limited to intersections, streets, highways and freeways, pedestrian and bicycle paths, and mass transit?	☐	☐	☐	☑
b) Conflict with an applicable congestion management program, including, but not limited to level of service standards and travel demand measures, or other standards established by the county congestion management agency for designated roads or highways?	☐	☐	☐	☑
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?	☐	☐	☐	☑
d) Substantially increase hazards because of a design feature (e.g. sharp curves or dangerous intersections) or incompatible uses (e.g. farm equipment)?	☐	☐	☐	☑
e) Result in inadequate emergency access?	☐	☐	☐	☑
f) Conflict with adopted policies, plans or programs regarding public transit, bicycle, or pedestrian facilities, or otherwise decrease the performance or safety of such facilities?	☐	☐	☐	☑

Setting

The Air District covers all of Alameda, Contra Costa, Marin, San Francisco, San Mateo, Santa Clara, and Napa Counties and portions of southwestern Solano and southern Sonoma Counties. Transportation systems located within the Bay Area include railroads, airports, waterways, and highways.

The transportation infrastructure for vehicles and trucks in the Bay Area ranges from single lane roadways to multilane interstate highways. The Bay Area currently contains over 1,300 directional miles of limited-access highways, which include both interstates and state highways. These facilities provide access to major employment centers and to destinations outside of the Bay Area. In addition, the Bay Area has over 33,000 directional miles of arterials and local streets, providing localized access to individual communities. Together, these roadway facilities accommodate nearly 158 million vehicle miles each weekday. The road network also serves over 600,000 vehicles that travel into or out of the region from adjacent areas. Over half of these interregional travelers use two regional gateways: Interstate 80 connecting Solano County and Yolo County, and Interstate 580 and Interstate 205 connecting Alameda County and San Joaquin County (ABAG, 2017).

The region is served by numerous interstate and U.S. freeways. On the west side of San Francisco Bay, Interstate 280 and U.S. 101 run north-south. U.S. 101 continues north of San Francisco into Marin County. Interstates 880 and 660 run north-south on the east side of the Bay. Interstate 80 starts in San Francisco, crosses the Bay Bridge, and runs northeast toward Sacramento. Interstate 80 is a six-lane north-south freeway which connects Contra Costa County to Solano County via the Carquinez Bridge. State Routes 29 and 84, both highways that allow at-grade crossings in certain parts of the region, become freeways that run east-west, and cross the Bay. Interstate 580 starts in San Rafael, crosses the Richmond-San Rafael Bridge, joins with Interstate 80, runs through Oakland, and then runs eastward toward Livermore. From the Benicia-Martinez Bridge, Interstate 680 extends north to Interstate 80 in Cordelia. Interstate 780 is a four lane, east-west freeway extending from the Benicia-Martinez Bridge west to I-80 in Vallejo.

There are over 11,500 transit route miles of service including heavy rail (BART), light rail (Muni Metro and Santa Clara Valley Transportation Authority or VTA Light Rail), commuter rail (Caltrain and Alameda Commuter Express or ACE), diesel and electric buses, cable cars, and ferries. This public transit system accommodates a total of almost 1.7 million passengers a day, with about 53 percent of daily passengers on Muni Metro, about 26 percent of daily passengers on BART, 11 percent on AC Transit, and nine percent on VTA. Amtrak provides long-distance passenger rail services to the Bay Area via the Capitol Corridor, San Joaquin, Coast Starlight, and California Zephyr lines (ABAG, 2017).

In addition to public transit systems and operators, private transit options have been increasing including privately operated commuter shuttles (e.g., Apple and Google), publicly accessible private shuttles (e.g., Emery Go-Round and Chariot), and transportation network companies (e.g., Uber and Lyft) (ABAG, 2017).

The Bay Area also has an extensive local system of bicycle routes and pedestrian paths and sidewalks. At a regional level, the share of workers driving alone was about 65 percent in 2015. The portion of commuters that carpool was about 10 percent in 2015, while an additional 12 percent utilize public transit.

About two percent of commuters walked to work in 2015. In addition, other modes of travel (bicycle, motorcycle, etc.), account for five percent of commuters in 2015 (ABAG, 2017).

The Bay Area is served by five seaports, which provide the opportunity for intermodal transfers to truck and railcars. The Port of Oakland is the third largest U.S. seaport on the West Coast (after the Ports of Long Beach and Los Angeles). Other seaports include the Port of San Francisco, the Port of Richmond, the Port of Benicia, and the Port of Redwood City. These seaports are supported by freight railroad services operated by Union Pacific and Burlington Northern Santa Fe.

The Bay Area is also served by three international airports: San Francisco International Airport, Oakland International Airport, and Norman Y. Mineta San Jose International Airport. Each of these airports provides mobility for people and freight nationally and internationally. The region is also served by one smaller airport with limited commercial service, Charles M. Schulz Sonoma County Airport, as well as numerous small general aviation airports.

Regulatory Background

Transportation planning is usually conducted at the state and county level. Planning for interstate highways is generally done by the California Department of Transportation.

Most local counties maintain a transportation agency that has the duties of transportation planning and administration of improvement projects within the county and implements the Transportation Improvement and Growth Management Program, and the congestion management plans (CMPs). The CMP identifies a system of state highways and regionally significant principal arterials and specifies level of service standards for those roadways.

Significance Criteria

The proposed project impacts on transportation and traffic will be considered significant if:

- A major roadway is closed to all through traffic, and no alternate route is available.
- The project conflicts with applicable policies, plans or programs establishing measures of effectiveness, thereby decreasing the performance or safety of any mode of transportation.
- There is an increase in traffic that is substantial in relation to the existing traffic load and capacity of the street system.
- The demand for parking facilities is substantially increased.
- Water borne, rail car or air traffic is substantially altered.
- Traffic hazards to motor vehicles, bicyclists or pedestrians are substantially increased.

Discussion of Impacts

XVI a and b. The expedited BARCT implementation schedule would require certain industrial facilities including refineries, manufacturing, bulk storage and transfer operations, cement plants, and petroleum coke calciners to reduce criteria pollutant emissions. These facilities may need to install additional air pollution control equipment, including domes on storage tanks, enclosures on fugitive emission sources, wet gas scrubbers, wet ESPs, SCRs, and LoTOx equipment.

Physical modifications at facilities due to installation of BARCT are expected to be limited to industrial facilities. Construction activities for new air pollution control equipment could be substantial for large facilities, e.g., FCCUs at refineries. However, construction activities would occur within the confines of existing industrial facilities and adjacent to existing industrial structures.

Construction activities associated with the proposed project would generate temporary noise associated with construction equipment and construction-related traffic. Construction would likely require truck trips to deliver equipment, construction workers, and construction equipment (e.g., forklift, welders, backhoes, cranes, and generators). All construction activities and related traffic would be temporary, would occur during daylight hours, would occur within the confines of existing industrial facilities, and would cease following the completion of construction. As discussed in "Population and Housing" above, the labor force in the Bay Area is sufficient to handle the temporary increase in construction-related jobs. No increase in permanent workers is expected due to the installation of additional air pollution control equipment or facility modifications. The installation of some air pollution control equipment, e.g., SCRs and wet gas scrubbers, could result in an increase of about 1-2 trucks per week to deliver ammonia, catalyst or alkaline materials to the facilities for the operation of the equipment. The increase in one truck per day would be a negligible increase in traffic in the Bay Area.

The proposed project is not expected to affect the performance of mass transit or non-motorized travel to street, highways and freeways, pedestrian or bicycle paths, as no increase in permanent workers is expected. No conflicts with any congestion management programs, to include level of service and travel demand measures, or other standards established by county congestion management agencies for designated roads or highways are expected. No changes are expected to parking capacity at or in the vicinity of affected facilities as the proposed project only pertains to equipment located within existing industrial facilities. Therefore, no significant adverse impacts resulting in changes to traffic patterns or levels of service at local intersections are expected.

XVI c. The expedited BARCT requirements are not expected to involve the delivery of materials via air so no increase in air traffic is expected. Construction associated with the proposed project is expected to be limited to air pollution control equipment and modifications at existing industrial facilities. All construction would take place at existing industrial facilities. Therefore, the proposed project would not result in a change in air traffic patterns or result in a change in location that results in substantial safety risks.

XVI d - e. The proposed expedited BARCT requirements would not increase traffic hazards or create incompatible uses. The proposed project does not involve construction of any roadways or other transportation design features, so no changes to current roadway designs that would increase traffic hazards are expected. Emergency access at industrial facilities affected by the expedited BARCT requirements is not expected to be impacted by the proposed project, as no modifications that effect traffic or access are expected to be required. The expedited BARCT requirements are not expected to increase vehicle trips or to alter the existing long-term circulation patterns, thus creating traffic hazards or impacting emergency access.

XVI f) The proposed expedited BARCT requirements are not expected to affect the performance of mass transit or non-motorized travel to street, highways and freeways, pedestrian or bicycle paths as construction associated with the proposed project is expected to be limited to existing industrial facilities. Implementation of expedited BARCT requirements could result in a temporary increase in traffic at these industrial facilities during the construction period and one or two delivery trucks per week. No increase in permanent workers is expected following the construction period. Therefore, the proposed project would not conflict with any congestion management programs or other plans, increase travel demand, impact public transit, or impact bicycle or pedestrian safety. No changes are expected to parking capacity at or in the vicinity of affected facilities as the BARCT requirements are not expected to require additional permanent employees. Therefore, no impacts resulting in changes to traffic patterns or adopted traffic plans or programs are expected.

Conclusion

Based upon the above considerations, significant adverse project-specific impacts to traffic and transportation are not expected to occur due to implementation of the expedited BARCT requirements and, therefore, will not be further evaluated in the Draft EIR.

	Potentially Significant Impact	Less Than Significant Impact With Mitigation Incorporated	Less-than-Significant Impact	No Impact
XVII. TRIBAL CULTURAL RESOURCES. Would the project cause a substantial adverse change in the significance of a tribal cultural resource, defined in Public Resources Code section 21074 as either a site, feature, place, cultural landscape that is geographically defined in terms of the size and scope of the landscape, sacred place, or object with cultural value to a California Native American Tribe, and that is:				
a) Listed or eligible for listing in the California Register of Historical Resources, or in a local register of historical resources as defined in Public Resourced Code section 5020.1(k), or	☐	☐	☐	☑
b) A resource determined by the lead agency, in its discretion and supported by substantial evidence, to be significant pursuant to criteria set forth in subdivision (c) of Public Resources Code Section 5024.1. In applying the criteria set forth in subdivision (c) of Public Resources Code Section 5024.1, the lead agency shall consider the significance of the resource to a California Native American Tribe.?	☐	☐	☐	☑

Setting

The Air District covers all of Alameda, Contra Costa, Marin, San Francisco, San Mateo, Santa Clara, and Napa Counties and portions of southwestern Solano and southern Sonoma Counties. Tribal cultural resources include site features, places, cultural landscapes and sacred places or objects which are of cultural value to a Tribe. The Carquinez Strait represents the entry point for the Sacramento and San Joaquin Rivers into the San Francisco Bay. Dense concentrations of Native American archaeological sites occur along the historic margins of San Francisco and San Pablo Bays. In addition, archaeological sites have also been identified in the following environmental settings in all Bay Area counties: near water sources, such as vernal pools and springs; along ridgetops and on midslope terraces; and at the base of hills and on alluvial flats. Native American archaeological sites have also been identified in the inland valleys of all Bay Area counties. Remains associated with a Native American archaeological site may include chert or obsidian flakes, projective points, mortars and pestles, and dark friable soil contain shell and bone dietary debris, heat-affected rock, or human burials (ABAG, 2017).

Native American populations, identified by their language, that lived within the Bay Area, included Costanoan, Eastern Miwok, Patwin, Coast Miwok, Pomo, and Wappo. Native villages and campsites were inhabited on a temporary basis and are found in several ecological niches due to the seasonal nature of their subsistence base. Remains of these early populations indicate that main villages, seldom more than 1,000 residents, were usually established along water courses and drainages. By the late 1760s, about 300,000 Native Americans lived in California (ABAG, 2013).

Regulatory Background

The State CEQA Guidelines were amended in July 2015 to include evaluation of impacts on tribal cultural resources. Tribal cultural resources include sites, features, places, cultural landscapes, sacred places, and objects with cultural value to a California Native American Tribe (Public Resources Code 21074).

Significance Criteria

The proposed project impacts to tribal resources will be considered significant if:

- The project results in the disturbance of a significant prehistoric or historic archaeological site or a property of Tribal cultural significance to a community or ethnic or social group or a California Native American Tribe.
- Unique objects with cultural value to a California Native American Tribe are present that could be disturbed by construction of the proposed project.

Discussion of Impacts

XVII a). As discussed in Section V, Cultural Resources, resources (buildings, structures, equipment) that are less than 50 years old are excluded from listing in the National Register of Historic Places unless they can be shown to be exceptionally important. The proposed expedited BARCT requirements may require the construction of air pollution control equipment and facility modifications to industrial facilities, adjacent to existing industrial structures. Affected facilities may have equipment or structures older than 50 years, however, this type of equipment does not meet the criteria identified in CEQA Guidelines §15064.5(a)(3), are not listed or eligible for listing in the California Register of Historic Resources or a local register of historical resources (Public Resources Code Section 5020.1(k), and are not considered to have cultural value to a California Native American Tribe.

Further, construction associated with the proposed project is expected to be limited to the construction at industrial facilities. All construction would take place at existing facilities that have been previously graded. Because construction will be limited to facilities that have been graded, the proposed expedited BARCT requirements are not expected to require physical changes to a site, feature, place, cultural landscape, sacred place or object with cultural value to a California Native American Tribe. The proposed BARCT requirements are not expected to result in a physical change to a resource determined to be eligible for inclusion or listed in the California Register of Historical Resources or included in a local register of historical resources.

As part of releasing this CEQA document for public review and comment, the document is circulated to the State Clearinghouse that provides notice of the proposed project to all California Native American Tribes that requested to be on the Native American Heritage Commission's (NAHC) notification list per Public Resources Code § 21080.3.1(b)(1). The NAHC notification list provides a 30-day period during which Native American Tribes may respond to the notice, in writing, requesting consultation on the proposed expedited BARCT requirements.

Since construction activities will be limited to existing industrial facilities that have been previously graded and developed, the proposed expedited BARCT requirements are not expected to affect historical or tribal resources as defined in Public Resources Section 5020.1(k), or 5024.1. Therefore, no impacts to tribal resources are anticipated to occur as a result of the proposed project.

Conclusion

Based upon the above considerations, significant adverse project-specific impacts to tribal cultural resources are not expected to occur due to implementation of the expedited BARCT requirements and, therefore, will not be further evaluated in the Draft EIR.

	Potentially Significant Impact	Less Than Significant Impact With Mitigation Incorporated	Less-than-Significant Impact	No Impact
XVIII. UTILITIES/SERVICE SYSTEMS. Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?	☑	☐	☐	☐
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☑	☐	☐	☐
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☑	☐
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or would new or expanded entitlements needed?	☑	☐	☐	☐
e) Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	☑	☐	☐	☐
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?	☐	☐	☑	☐
g) Comply with federal, state, and local statutes and regulations related to solid waste?	☐	☐	☐	☑

Setting

Given the large area covered by the Air District, public utilities are provided by a wide variety of local agencies. The San Francisco Bay Hydrologic Region covers approximately 4,550 square miles and encompasses numerous individual watersheds that drain into the San Francisco Bay and directly into the Pacific Ocean. Water is supplied to affected facilities by water purveyors in the Bay Area, which include the Alameda County Water District, Contra Costa Water District, East Bay Municipal District, Marin Municipal Water District, Napa Water Department, San Francisco Public Utilities Commission, Santa

Clara Valley Water District, Solano County Water Agency, Sonoma County Water Agency, and the Zone 7 Water Agency.

Solid waste includes the garbage, refuse and other discarded solid materials generated by residential, commercial, and industrial activities. Solid waste is handled through a variety of municipalities, through recycling activities and at disposal sites. The Bay Area is currently served by 16 privately operated landfills and one operated by the Sonoma County Public Works Department. The 16 landfills have a total remaining capacity of 261,889,000 cubic yards, or a total daily throughput of 41,804 tons per day (ABAG, 2017).

There are no hazardous waste disposal sites within the jurisdiction of the Air District. Hazardous waste generated at facilities, which is not recycled off-site, is required to be disposed of at a licensed hazardous waste disposal facility. Two such facilities are the Chemical Waste Management Inc. (CWMI) Kettleman Hills facility in King's County, and the Safety-Kleen facility in Buttonwillow (Kern County). Hazardous waste can also be transported to permitted facilities outside of California.

Regulatory Background

City and/or County General Plans usually contain goals and policies to assure adequate utilities and service systems are maintained within the local jurisdiction.

Significance Criteria

The proposed project impacts on utilities/service systems will be considered significant if:

- The capacities of existing or proposed wastewater treatment facilities and the sanitary sewer system are not sufficient to meet the needs of the project.
- An increase in demand for utilities impacts the current capacities of the electric utilities.
- The existing water supply does not have the capacity to meet the increased demands of the project, or the project would use a substantial amount of potable water.
- The project increases demand for water by more than 263,000 gallons per day.
- The generation and disposal of hazardous and non-hazardous waste exceeds the capacity of designated landfills.

Discussion of Impacts

XVIII a, b, d and e). The potential water use and wastewater impacts associated with implementation of the proposed expedited BARCT requirements were discussed under Hydrology and Water Quality (see Section IX a.). Certain types of air pollution control devices (e.g., wet gas scrubbers) could result in substantial water use and wastewater discharge. Therefore, these topics will be evaluated further in the Draft EIR.

XVIII c). Air pollution control equipment and facility modifications to implement the expedited BARCT requirements would occur within the confines of existing industrial facilities where stormwater is already controlled. The proposed project is not expected to require additional paving that would generate additional stormwater runoff. Therefore, the proposed project would not be expected to alter the existing drainage systems or require the construction of new storm water drainage facilities. Nor would the proposed project create or contribute runoff water that would exceed the capacity of existing or planned storm water drainage systems or provide substantial additional sources of polluted runoff. Therefore, no significant adverse impacts on storm drainage facilities are expected.

XVIII f and g). Construction of air pollution control equipment as a result of the expedited BARCT requirements is not expected to significantly increase solid or hazardous wastes generated by the affected existing facilities. Some air pollution control equipment uses catalysts that need to be replaced when they are depleted. The catalyst is usually recycled because of the metal content of the catalyst and would not be expected to generate additional hazardous or solid waste that requires disposal. Waste streams from affected facilities would be treated/disposed/recycled in the same manner as they currently are handled. Therefore, no significant impacts to solid or hazardous waste disposal facilities are expected due to the proposed project. Facilities are expected to continue to comply with all applicable federal, state, and local statutes and regulations related to solid and hazardous wastes.

Conclusion

Based upon the above considerations, the potentially significant impacts associated with water use and wastewater treatment will be evaluated in the Draft EIR, as discussed in Section IX – Hydrology and Water Quality above. The potential project-specific impacts to other utilities and service systems are not expected to occur due to implementation of the expedited BARCT requirements and, therefore, will not be further evaluated in the Draft EIR.

	Potentially Significant Impact	Less Than Significant Impact With Mitigation Incorporated	Less Than Significant Impact	No Impact
XIX. MANDATORY FINDINGS OF SIGNIFICANCE.				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal, or eliminate important examples of the major periods of California history or prehistory?	☐	☐	☐	☑
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)	☑	☐	☐	☐
c) Does the project have environmental effects that will cause substantial adverse effects on human beings, either directly or indirectly?	☑	☐	☐	☐

Discussion of Impacts

XIX a. The proposed expedited BARCT requirements are designed to reduce criteria pollutant emissions from industrial facilities in the Bay Area. Modifications may be required to industrial facilities to install air pollution control equipment. As discussed in Section IV, Biological Resources; Section V, Cultural Resources; and Section XVIII no significant adverse impacts are expected to biological, cultural, or tribal resources. The facilities affected by the expedited BARCT requirements are existing industrial facilities that have been graded and developed, where native biological resources have been removed or are non-existent. Similarly, impacts to cultural or tribal resources would not be expected to occur.

Therefore, the proposed expedited BARCT requirements do not have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal, or eliminate important examples of the major periods of California history or prehistory, as discussed in the previous sections of the CEQA checklist. As discussed in Section IV, Biological Resources; Section V, Cultural Resources; and Section

XVII, Tribal Cultural Resources, no significant adverse impacts are expected to biological, cultural, or tribal cultural resources.

XIX b-c. The proposed expedited BARCT requirements are expected to result in a reduction in criteria pollutant emissions and implement portions of the AB 617 requirements, helping to achieve the goals of reducing ozone and PM in the Bay Area, thus improving public health and air quality in the region. As discussed in Section III, Air Quality, emissions during construction activities and operation could potentially exceed applicable significance thresholds, which represent levels at which a project's individual emissions would result in a cumulatively considerable contribution to the Air District's existing air quality conditions. (However, please see the discussion in Chapter 2, Section III, "Air Quality", above, regarding the applicability of the Air District's project-level CEQA thresholds to rule development projects.) The hazard associated with the additional use of ammonia and other potentially hazardous materials may also result in impacts, as well as potential water demand and wastewater treatment impacts. These potential impacts will be evaluated in the Draft EIR.

As discussed in the previous checklist discussions, the proposed expedited BARCT requirements are not expected to exceed any of the applicable significance thresholds, which also serve as the cumulative significance thresholds, for the environmental resources of aesthetics, agricultural and forestry resources, biological resources, cultural resources, geology and soils, greenhouse gases, land use and planning, mineral resources, noise, population and housing, public services, recreation, transportation and traffic, and tribal cultural resources. Therefore, the proposed project impacts on these environmental resources are not considered to be significant or cumulatively considerable (CEQA Guidelines §15064 (h)(1)) and will not be evaluated in the Draft EIR.

Chapter 3

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APPENDIX A
AB 617 EXPEDITED BARCT IMPLEMENTATION SCHEDULE
COMMENT LETTERS RECEIVED ON THE NOP/IS

The following are comments received on the NOP/IS for the AB 617 Expedited BARCT Implementation Schedule Project. The NOP/IS was circulated for a 30-day public review and comment period starting August 7, 2018 and ending September 7, 2018. In addition, the BAAQMD conducted a CEQA scoping meeting at the Air District Headquarters' Yerba Room on August 24, 2018 to take public comment on the proposed project.

The BAAQMD received two comment letters on the NOP/IS during the public review period and did not receive public comments at the public scoping meeting. The two comment letters that were received during the public comment period are provided below.

David Joe

From: Osterberg, Todd Eugene <TOsterberg@chevron.com>
Sent: Thursday, August 23, 2018 3:09 PM
To: David Joe
Cc: Yang, Steven
Subject: Chevron Richmond BARCT comment 8-5

Good afternoon David,

I have a comment regarding AB617 BARCT implementation in relation to storage tanks (Reg. 8-5):
Impacts to the appearance of the community skyline and other aesthetics imposed by the installation of BARCT, for example tank geodesic doming, should be considered in the rule making process.

Thank you.

Todd E Osterberg
CHMM
Environmental Specialist-Air
Chevron Richmond Refinery

Chevron Products Company
Global Downstream
Tel 510 242 2813
Cell   925 951 7109

STATE OF CALIFORNIA Edmund G. Brown Jr., Governor

NATIVE AMERICAN HERITAGE COMMISSION
Cultural and Environmental Department
1550 Harbor Blvd., Suite 100
West Sacramento, CA 95691
Phone (916) 373-3710

August 8, 2018

Victor Douglas
Bay Area Air Quality Management District
375 Beale Street, Suite 600
San Francisco, CA 94105

Also sent via e-mail: vdouglas@baaqmd.gov

RE: SCH# 2018082003, Expedited Best Available Retrofit Control Technology (BARCT) Implementation Schedule Project; Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma Counties, California

Dear Mr. Douglas:

The Native American Heritage Commission has received the Notice of Preparation (NOP) for Draft Environmental Impact Report for the project referenced above. The California Environmental Quality Act (CEQA) (Pub. Resources Code § 21000 et seq.), specifically Public Resources Code section 21084.1, states that a project that may cause a substantial adverse change in the significance of an historical resource is a project that may have a significant effect on the environment. (Pub. Resources Code § 21084.1; Cal. Code Regs., tit.14, § 15064.5 (b) (CEQA Guidelines Section 15064.5 (b)). If there is substantial evidence, in light of the whole record before a lead agency, that a project may have a significant effect on the environment, an environmental impact report (EIR) shall be prepared. (Pub. Resources Code § 21080 (d); Cal. Code Regs., tit. 14, § 15064 subd. (a)(1) (CEQA Guidelines § 15064 (a)(1)). In order to determine whether a project will cause a substantial adverse change in the significance of a historical resource, a lead agency will need to determine whether there are historical resources with the area of project effect (APE).

CEQA was amended significantly in 2014. Assembly Bill 52 (Gatto, Chapter 532, Statutes of 2014) (AB 52) amended CEQA to create a **separate category of cultural resources**, "tribal cultural resources" (Pub. Resources Code § 21074) and provides that a project with an effect that may cause a substantial adverse change in the significance of a tribal cultural resource is a project that may have a significant effect on the environment (Pub. Resources Code § 21084.2). Please reference California Natural Resources Agency (2016) "Final Text for tribal cultural resources update to Appendix G: Environmental Checklist Form," http://resources.ca.gov/ceqa/docs/ab52/Clean-final-AB-52-App-G-text-Submitted.pdf. Public agencies shall, when feasible, avoid damaging effects to any tribal cultural resource. (Pub. Resources Code § 21084.3 (a)). **AB 52 applies to any project for which a notice of preparation or a notice of negative declaration or mitigated negative declaration is filed on or after July 1, 2015.** If your project involves the adoption of or amendment to a general plan or a specific plan, or the designation or proposed designation of open space, on or after March 1, 2005, it may also be subject to Senate Bill 18 (Burton, Chapter 905, Statutes of 2004) (SB 18). **Both SB 18 and AB 52 have tribal consultation requirements**. If your project is also subject to the federal National Environmental Policy Act (42 U.S.C. § 4321 et seq.) (NEPA), the tribal consultation requirements of Section 106 of the National Historic Preservation Act of 1966 (154 U.S.C. 300101, 36 C.F.R. § 800 et seq.) may also apply.

The NAHC recommends **lead agencies consult with all California Native American tribes** that are traditionally and culturally affiliated with the geographic area of your proposed project as early as possible in order to avoid inadvertent discoveries of Native American human remains and best protect tribal cultural resources. Below is a brief summary of portions of AB 52 and SB 18 as well as the NAHC's recommendations for conducting cultural resources assessments. **Consult your legal counsel about compliance with AB 52 and SB 18 as well as compliance with any other applicable laws**.

AB 52

AB 52 has added to CEQA the additional requirements listed below, along with many other requirements:

1. Fourteen Day Period to Provide Notice of Completion of an Application/Decision to Undertake a Project: Within fourteen (14) days of determining that an application for a project is complete or of a decision by a public agency to undertake a project, a **lead agency** shall provide formal notification to a designated contact of, or tribal representative of, traditionally and culturally affiliated California Native American tribes that have requested notice, to be accomplished by at least one written notice that includes:
   - **a.** A brief description of the project.
   - **b.** The lead agency contact information.
   - **c.** Notification that the California Native American tribe has 30 days to request consultation. (Pub. Resources Code § 21080.3.1 (d)).
   - **d.** A "California Native American tribe" is defined as a Native American tribe located in California that is on the contact list maintained by the NAHC for the purposes of Chapter 905 of Statutes of 2004 (SB 18). (Pub. Resources Code § 21073).

2. Begin Consultation Within 30 Days of Receiving a Tribe's Request for Consultation and Before Releasing a Negative Declaration, Mitigated Negative Declaration, or Environmental Impact Report: A **lead agency** shall begin the consultation process within 30 days of receiving a request for consultation from a California Native American tribe that is traditionally and culturally affiliated with the geographic area of the proposed project. (Pub. Resources Code § 21080.3.1, subds. (d) and (e)) and prior to the release of a negative declaration, mitigated negative declaration or environmental impact report. (Pub. Resources Code § 21080.3.1(b)).
   - **a.** For purposes of AB 52, "consultation shall have the same meaning as provided in Gov. Code § 65352.4 (SB 18). (Pub. Resources Code § 21080.3.1 (b)).

3. Mandatory Topics of Consultation If Requested by a Tribe: The following topics of consultation, if a tribe requests to discuss them, are mandatory topics of consultation:
   - **a.** Alternatives to the project**.**
   - **b.** Recommended mitigation measures**.**
   - **c.** Significant effects**.** (Pub. Resources Code § 21080.3.2 (a)).

4. Discretionary Topics of Consultation: The following topics are discretionary topics of consultation:
   - **a.** Type of environmental review necessary.
   - **b.** Significance of the tribal cultural resources.
   - **c.** Significance of the project's impacts on tribal cultural resources.
   - **d.** If necessary, project alternatives or appropriate measures for preservation or mitigation that the tribe may recommend to the lead agency. (Pub. Resources Code § 21080.3.2 (a)).

5. Confidentiality of Information Submitted by a Tribe During the Environmental Review Process: With some exceptions, any information, including but not limited to, the location, description, and use of tribal cultural resources submitted by a California Native American tribe during the environmental review process shall not be included in the environmental document or otherwise disclosed by the lead agency or any other public agency to the public, consistent with Government Code sections 6254 (r) and 6254.10. Any information submitted by a California Native American tribe during the consultation or environmental review process shall be published in a confidential appendix to the environmental document unless the tribe that provided the information consents, in writing, to the disclosure of some or all of the information to the public. (Pub. Resources Code § 21082.3 (c)(1)).

6. Discussion of Impacts to Tribal Cultural Resources in the Environmental Document: If a project may have a significant impact on a tribal cultural resource, the lead agency's environmental document shall discuss both of the following:
   - **a.** Whether the proposed project has a significant impact on an identified tribal cultural resource.
   - **b.** Whether feasible alternatives or mitigation measures, including those measures that may be agreed to pursuant to Public Resources Code section 21082.3, subdivision (a), avoid or substantially lessen the impact on the identified tribal cultural resource. (Pub. Resources Code § 21082.3 (b)).

7. Conclusion of Consultation: Consultation with a tribe shall be considered concluded when either of the following occurs:
  - **a.** The parties agree to measures to mitigate or avoid a significant effect, if a significant effect exists, on a tribal cultural resource; or
  - **b.** A party, acting in good faith and after reasonable effort, concludes that mutual agreement cannot be reached. (Pub. Resources Code § 21080.3.2 (b)).

8. Recommending Mitigation Measures Agreed Upon in Consultation in the Environmental Document: Any mitigation measures agreed upon in the consultation conducted pursuant to Public Resources Code section 21080.3.2 shall be recommended for inclusion in the environmental document and in an adopted mitigation monitoring and reporting program, if determined to avoid or lessen the impact pursuant to Public Resources Code section 21082.3, subdivision (b), paragraph 2, and shall be fully enforceable. (Pub. Resources Code § 21082.3 (a)).

9. Required Consideration of Feasible Mitigation: If mitigation measures recommended by the staff of the lead agency as a result of the consultation process are not included in the environmental document or if there are no agreed upon mitigation measures at the conclusion of consultation, or if consultation does not occur, and if substantial evidence demonstrates that a project will cause a significant effect to a tribal cultural resource, the lead agency shall consider feasible mitigation pursuant to Public Resources Code section 21084.3 (b). (Pub. Resources Code § 21082.3 (e)).

10. Examples of Mitigation Measures That, If Feasible, May Be Considered to Avoid or Minimize Significant Adverse Impacts to Tribal Cultural Resources:
  - **a.** Avoidance and preservation of the resources in place, including, but not limited to**:**
    - **i.** Planning and construction to avoid the resources and protect the cultural and natural context.
    - **ii.** Planning greenspace, parks, or other open space, to incorporate the resources with culturally appropriate protection and management criteria.
  - **b.** Treating the resource with culturally appropriate dignity, taking into account the tribal cultural values and meaning of the resource, including, but not limited to, the following:
    - **i.** Protecting the cultural character and integrity of the resource.
    - **ii.** Protecting the traditional use of the resource.
    - **iii.** Protecting the confidentiality of the resource.
  - **c.** Permanent conservation easements or other interests in real property, with culturally appropriate management criteria for the purposes of preserving or utilizing the resources or places.
  - **d.** Protecting the resource. (Pub. Resource Code § 21084.3 (b)).
  - **e.** Please note that a federally recognized California Native American tribe or a nonfederally recognized California Native American tribe that is on the contact list maintained by the NAHC to protect a California prehistoric, archaeological, cultural, spiritual, or ceremonial place may acquire and hold conservation easements if the conservation easement is voluntarily conveyed. (Civ. Code § 815.3 (c)).
  - **f.** Please note that it is the policy of the state that Native American remains and associated grave artifacts shall be repatriated. (Pub. Resources Code § 5097.991).

11. Prerequisites for Certifying an Environmental Impact Report or Adopting a Mitigated Negative Declaration or Negative Declaration with a Significant Impact on an Identified Tribal Cultural Resource: An environmental impact report may not be certified, nor may a mitigated negative declaration or a negative declaration be adopted unless one of the following occurs:
  - **a.** The consultation process between the tribes and the lead agency has occurred as provided in Public Resources Code sections 21080.3.1 and 21080.3.2 and concluded pursuant to Public Resources Code section 21080.3.2.
  - **b.** The tribe that requested consultation failed to provide comments to the lead agency or otherwise failed to engage in the consultation process.
  - **c.** The lead agency provided notice of the project to the tribe in compliance with Public Resources Code section 21080.3.1 (d) and the tribe failed to request consultation within 30 days. (Pub. Resources Code § 21082.3 (d)).

  This process should be documented in the Cultural Resources section of your environmental document.

The NAHC's PowerPoint presentation titled, "Tribal Consultation Under AB 52: Requirements and Best Practices" may be found online at: http://nahc.ca.gov/wp-content/uploads/2015/10/AB52TribalConsultation_CalEPAPDF.pdf

SB 18

SB 18 applies to local governments and requires **local governments** to contact, provide notice to, refer plans to, and consult with tribes prior to the adoption or amendment of a general plan or a specific plan, or the designation of open space. (Gov. Code § 65352.3). Local governments should consult the Governor's Office of Planning and Research's "Tribal Consultation Guidelines," which can be found online at: https://www.opr.ca.gov/docs/09_14_05_Updated_Guidelines_922.pdf

Some of SB 18's provisions include:

1. Tribal Consultation: If a local government considers a proposal to adopt or amend a general plan or a specific plan, or to designate open space it is required to contact the appropriate tribes identified by the NAHC by requesting a "Tribal Consultation List." If a tribe, once contacted, requests consultation the local government must consult with the tribe on the plan proposal. **A tribe has 90 days from the date of receipt of notification to request consultation unless a shorter timeframe has been agreed to by the tribe.** (Gov. Code § 65352.3 (a)(2)).
2. No Statutory Time Limit on SB 18 Tribal Consultation. There is no statutory time limit on SB 18 tribal consultation.
3. Confidentiality: Consistent with the guidelines developed and adopted by the Office of Planning and Research pursuant to Gov. Code section 65040.2, the city or county shall protect the confidentiality of the information concerning the specific identity, location, character, and use of places, features and objects described in Public Resources Code sections 5097.9 and 5097.993 that are within the city's or county's jurisdiction. (Gov. Code § 65352.3 (b)).
4. Conclusion of SB 18 Tribal Consultation: Consultation should be concluded at the point in which:
   - **a.** The parties to the consultation come to a mutual agreement concerning the appropriate measures for preservation or mitigation; or
   - **b.** Either the local government or the tribe, acting in good faith and after reasonable effort, concludes that mutual agreement cannot be reached concerning the appropriate measures of preservation or mitigation. (Tribal Consultation Guidelines, Governor's Office of Planning and Research (2005) at p. 18).

Agencies should be aware that neither AB 52 nor SB 18 precludes agencies from initiating tribal consultation with tribes that are traditionally and culturally affiliated with their jurisdictions before the timeframes provided in AB 52 and SB 18. For that reason, we urge you to continue to request Native American Tribal Contact Lists and "Sacred Lands File" searches from the NAHC. The request forms can be found online at: http://nahc.ca.gov/resources/forms/

NAHC Recommendations for Cultural Resources Assessments

To adequately assess the existence and significance of tribal cultural resources and plan for avoidance, preservation in place, or barring both, mitigation of project-related impacts to tribal cultural resources, the NAHC recommends the following actions:

1. Contact the appropriate regional California Historical Research Information System (CHRIS) Center (http://ohp.parks.ca.gov/?page_id=1068) for an archaeological records search. The records search will determine:
   - **a.** If part or all of the APE has been previously surveyed for cultural resources.
   - **b.** If any known cultural resources have been already been recorded on or adjacent to the APE.
   - **c.** If the probability is low, moderate, or high that cultural resources are located in the APE.
   - **d.** If a survey is required to determine whether previously unrecorded cultural resources are present.

2. If an archaeological inventory survey is required, the final stage is the preparation of a professional report detailing the findings and recommendations of the records search and field survey.
   - **a.** The final report containing site forms, site significance, and mitigation measures should be submitted immediately to the planning department. All information regarding site locations, Native American human remains, and associated funerary objects should be in a separate confidential addendum and not be made available for public disclosure.

  b. The final written report should be submitted within 3 months after work has been completed to the appropriate regional CHRIS center.

3. Contact the NAHC for:
   a. A Sacred Lands File search. Remember that tribes do not always record their sacred sites in the Sacred Lands File, nor are they required to do so. A Sacred Lands File search is not a substitute for consultation with tribes that are traditionally and culturally affiliated with the geographic area of the project's APE.
   b. A Native American Tribal Consultation List of appropriate tribes for consultation concerning the project site and to assist in planning for avoidance, preservation in place, or, failing both, mitigation measures.

4. Remember that the lack of surface evidence of archaeological resources (including tribal cultural resources) does not preclude their subsurface existence.
   a. Lead agencies should include in their mitigation and monitoring reporting program plan provisions for the identification and evaluation of inadvertently discovered archaeological resources per Cal. Code Regs., tit. 14, section 15064.5(f) (CEQA Guidelines section 15064.5(f)). In areas of identified archaeological sensitivity, a certified archaeologist and a culturally affiliated Native American with knowledge of cultural resources should monitor all ground-disturbing activities.
   b. Lead agencies should include in their mitigation and monitoring reporting program plans provisions for the disposition of recovered cultural items that are not burial associated in consultation with culturally affiliated Native Americans.
   c. Lead agencies should include in their mitigation and monitoring reporting program plans provisions for the treatment and disposition of inadvertently discovered Native American human remains. Health and Safety Code section 7050.5, Public Resources Code section 5097.98, and Cal. Code Regs., tit. 14, section 15064.5, subdivisions (d) and (e) (CEQA Guidelines section 15064.5, subds. (d) and (e)) address the processes to be followed in the event of an inadvertent discovery of any Native American human remains and associated grave goods in a location other than a dedicated cemetery.

Please contact me if you need any additional information at gayle.totton@nahc.ca.gov.

Sincerely,

Gayle Totton

Gayle Totton, M.A., Ph.D.
Associate Governmental Program Analyst
(916) 373-3714

cc: State Clearinghouse

APPENDIX B

EMISSION CALCULATONS

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Appendix B
Expedited BARCT Implementation Schedule
Construction Emissions Summary

ACTIVITY	ROG	CO	NOx	SOx	PM10	PM2.5
Peak Daily Concurrent Construction Emissions (lb/day)						
5 VRU, Incinerators, or Vapor Combustors	0.2	1.8	2.3	0.1	0.8	0.4
5 Domes	12.2	123.9	116.9	0.4	13.0	7.8
1 Lime Injector	<0.1	0.4	0.5	<0.01	0.2	0.1
1 Large SCR	7.1	20.6	23.5	0.7	4.6	4.0
3 Refinery WGS or LoTox Scrubber	51	201	252	0.3	117	69
Total Concurrent Emissions (lbs/day)	70.5	347.7	395.2	1.5	135.6	81.3
Significance Thresholds	54	None	54	None	82	54
Significant?	Yes	--	Yes	--	Yes	Yes

Appendix B
Expedited BARCT Implementation Schedule
Operational Emissions Summary

ACTIVITY	ROG	CO	NOx	SOx	PM10	PM2.5	CO2e (MT)
Daily Concurrent Operational Emissions (lb/day)							
15 Oxidizers	2.4	107	13.1	0.2	2.6	2.6	18.7
Electricity for WGS, LoTox, SCR, and ESP	--	--	--	--	--	--	1.2
Delivery Trucks for Caustic, Ammonia, and Lime	2.7	0.4	12.5	0.1	0.3	0.1	0.7
Total Concurrent Emissions	5.1	107.4	25.6	0.3	2.9	2.7	20.6
Reductions from Project Implementation(1)	411.0	--	--	6932	--	--	--
Net Concurrent Emissions(2)	-405.9	107.4	25.6	-6931.8	2.9	2.7	20.6
Significance Thresholds	54	None	54	None	82	54	None
Significant?	No	--	No	--	No	No	--
Annual Concurrent Operational Emissions (tons/yr)							
15 Oxidizers	0.4	19.5	2.4	0.1	0.5	0.5	6825.7
Electricity for WGS, LoTox, SCR, and ESP	--	--	--	--	--	--	451.9
Delivery Trucks for Caustic, Ammonia, and Lime	0.1	0.1	0.5	0.1	0.1	0.1	111.2
Total Concurrent Emissions	0.5	19.5	2.9	0.1	0.6	0.5	7388.8
Reductions from Project Implementation	75.0	0.0	0.0	1265.0	0.0	0.0	0.0
Net Concurrent Emissions(2)	-74.5	19.5	2.9	-1264.9	0.6	0.5	7388.8
Significance Thresholds	10	None	10	None	15	10	10000
Significant?	No	--	No	--	No	No	No

Note:

(1) Assumes 365 days of operations.

(2) Negative numbers indicate emission benefit.

Appendix B
Expedited BARCT Implementation Schedule
Typical Construction Equipment

Equipment Type	ROG (lb/hr)	CO (lb/hr)	NOx (lb/hr)	SOx (lb/hr)	PM10 (lb/hr)	CO2e (lb/hr)
Aerial Lift	0.00	0.17	0.10	0.00	0.00	0.01
Backhoe	0.02	0.36	0.27	0.00	0.02	0.02
Compressor	0.02	0.21	0.13	0.00	0.01	0.01
Concrete Saw	0.03	0.25	0.18	0.00	0.02	0.01
Crane	0.05	0.40	0.72	0.00	0.03	0.04
Drill Rig Large	0.08	0.50	1.06	0.00	0.04	0.07
Excavator	0.02	0.51	0.31	0.00	0.01	0.03
Forklift	0.02	0.22	0.17	0.00	0.01	0.01
Front End Loader	0.05	0.44	0.60	0.00	0.03	0.04
Generator	0.02	0.22	0.13	0.00	0.01	0.01
Light Plants	0.02	0.29	0.13	0.00	0.01	0.01
Welding Machine	0.03	0.23	0.18	0.00	0.02	0.01

Off-Road 2011 for 2019 fleet. CO emissions from SCAQMD, 2006

Equipment Type	ROG (lb/day)	CO (lb/day)	NOx (lb/day)	SOx (lb/day)	PM10 (lb/day)	CO2e (lb/day)
Aerial Lift	0.037995	1.372031	0.783044	0.003538	0.015551	0.085244
Backhoe	0.182131	2.904058	2.191215	0.006362	0.130734	0.153284
Compressor	0.182209	1.662714	1.016855	0.002355	0.079061	0.05674
Concrete Saw	0.265078	1.975434	1.448896	0.003111	0.121785	0.074946
Crane	0.420426	3.185271	5.794775	0.011741	0.266954	0.282861
Drill Rig Large	0.639636	4.007488	8.517353	0.022198	0.335185	0.534803
Excavator	0.19881	4.111668	2.482458	0.010666	0.103511	0.256955
Forklift	0.133628	1.732806	1.389462	0.003185	0.099319	0.076729
Front End Loader	0.378682	3.548417	4.802831	0.01285	0.21504	0.309592
Generator	0.182209	1.764821	1.016855	0.002355	0.079061	0.05674
Light Plants	0.182209	2.312164	1.016855	0.002355	0.079061	0.05674
Welding Machine	0.265078	1.817133	1.448896	0.003111	0.121785	0.074946

Assumes 8 hour days.

Appendix B
Expedited BARCT Implementation Schedule
Dome Off-road Construction Emissions

Phase	Equipment	HP	Amount	Days	Hr/Day	Total Hours	Emission Factors (lb/hr)						Emissions (lb)						
							VOC	CO	NOx	SOx	PM10	CO2e	VOC	CO	NOx	SOx	PM10	PM2.5	CO2e (MT)
Equipment Installation	Air Compressor	Comp	1	20	8	160	0.02	0.21	0.13	0.00	0.01	0.01	3.64	33.25	20.34	0.05	1.58	1.57	1.13
Equipment Installation	Crane	Comp	1	20	4	80	0.05	0.40	0.72	0.00	0.03	0.04	4.20	31.85	57.95	0.12	2.67	2.64	2.83
Equipment Installation	Forklift	Comp	1	20	8	160	0.02	0.22	0.17	0.00	0.01	0.01	2.67	34.66	27.79	0.06	1.99	1.97	1.53
Equipment Installation	Generator Sets	50	2	20	8	320	0.02	0.28	0.13	0.00	0.01	0.01	7.29	89.97	40.67	0.09	3.16	3.13	2.27
Equipment Installation	Aerial Lift	Comp	4	20	8	640	0.00	0.17	0.10	0.00	0.00	0.01	3.04	109.76	62.64	0.28	1.24	1.23	6.82
Equipment Installation	Welder	50	4	20	8	640	0.03	0.23	0.18	0.00	0.02	0.01	21.21	145.37	115.91	0.25	9.74	9.65	6.00
Emissions for One Dome Construction (tons)													**0.02**	**0.22**	**0.16**	**0.00**	**0.01**	**0.01**	**20.58**
Peak Daily Emissions (lb/day)													**2.10**	**22.24**	**16.27**	**0.04**	**1.02**	**1.01**	**1.03**

Notes:
(1) Off-Road 2011 for 2019 fleet. CO emissions from SCAQMD, 2006 : http://www.aqmd.gov/ceqa/handbook/offroad/offroadEF07_25.xls
(2) Carbon Dioxide Equivalents (CO2e) are based on fuel use and default emission factors for diesel. Metric tons.

Appendix B
Expedited BARCT Implementation Schedule
Dome On-road Construction Emissions

Phase	Vehicle	Trip Length	Total Trips	VMT	VOC (lb/mi)	CO (lb/mi)	NOx (lb/mi)	SOx (lb/mi)	PM (lb/mi)	Fugitive PM	CO2e (lb/mile)	VOC (lbs)	CO (lbs)	NOx (lbs)	SOx (lbs)	PM10 (lbs)	PM2.5 (lbs)	CO2e (tonnes)
Equipment Installation	Commuters	24.8	400	9920	0.000	0.002	0.000	0.000	0.000	0.000	0.906	0.426	17.070	2.743	0.070	3.251	1.431	4.078
Equipment Installation	Delivery	40	10	400	0.000	0.002	0.007	0.000	0.000	0.000	2.247	0.169	0.758	2.662	0.010	0.379	0.224	0.408
Equipment Installation	HHDT	40	10	400	0.000	0.002	0.011	0.000	0.000	0.002	3.745	0.141	0.923	4.311	0.014	1.032	0.264	0.680
Emissions for One Dome Construction (Total Emissions)												**0.000**	**0.009**	**0.005**	**0.000**	**0.002**	**0.001**	**5.165**
Emissions for One Dome Construction (Peak Daily)												**0.331**	**2.535**	**7.110**	**0.028**	**1.574**	**0.560**	**1.291**

Notes:

(1) Peak day assumes 20 workers per day and all deliverise occur in one day. Project emissiosn based on 20 commuters per day for 20 days.

(2) Emfac2014 emission factors for the San Francisco Bay Area District for 2019 fleet.

(3) Fugitive PM emission calculations for travel on paved roads from EPA AP-42 Section 13.2.1, January 2011

$E = k(sL)^{0.91} \times (W)^{1.02}$

Where: k = 0.0022 lb/VMT for PM10, sL = road silt loading (gms/m2)

(0.03 for major/collector roads), W = weight of vehicles (2.5 tons for light; 5.5 for medium trucks,

and 24 for heavy trucks)

(4) Carbon Dioxide Equivalence (CO_E) = CO_2 + CH_4 * 21 + N2O*310

where CO2 emissions factors are from Emfac2011. CH4 and N2O emissions factors are from Direct Emissions from Mobile Combustion Sources, EPA 2008.

where light vehicle are gasoline light duty trucks.

where medium/heavy duty vehicle are diesel heavy duty trucks.

Chemical	2019 Light	2019 Medium	2019 Heavy
CO2 (lb/mi)	0.8949	2.2430	3.7418
CH4 (g/mi)	0.0148	0.0051	0.0051
N2O (g/mi)	0.0157	0.0048	0.0048
CO2e (lb/mi)	0.906	2.247	3.745

Appendix B
Expedited BARCT Implementation Schedule
Dome Construction Emission Summary

ACTIVITY	ROG	CO	NOx	SOx	PM10	PM2.5	CO2e (MT)
Peak Daily Emissions (lb/day)							
Construction of One Dome	2.43	24.78	23.37	0.07	2.59	1.57	2.32
Construction of Five Concurrent Domes	12.17	123.89	116.87	0.35	12.97	7.85	11.60
Total Emissions (tons)							
Construction of One Dome	0.02	0.23	0.17	0.00	0.01	0.01	25.75
Construction of Five Dome	0.11	1.16	0.84	0.00	0.06	0.06	128.74
Construction of 20 Domes	0.43	4.64	3.35	0.01	0.25	0.22	514.96

Appendix B
Expedited BARCT Implementation Schedule
ESP Off-road Construction Emissions

Phase	Equipment	Offroad Category	HP	Amount	Days	Hr/Day	Total Hours	Emission Factors (lb/hr) VOC	CO	NOx	SOx	PM10	CO2e	Emissions (lb) VOC	CO	NOx	SOx	PM10	PM2.5	CO2e (MT)
Site Prep and Foundation	Aerial Lift	Aerial Lift	Comp	0	120	0	0	0.00	0.17	0.10	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Site Prep and Foundation	Backhoe	Tractors/Loaders/Backhoes	Comp	1	120	20	2400	0.02	0.36	0.27	0.00	0.02	0.02	54.64	871.22	657.36	1.91	39.22	38.83	45.99
Site Prep and Foundation	Compressor	Other Industrial Equipment	50	1	120	20	2400	0.02	0.21	0.13	0.00	0.01	0.01	54.66	498.81	305.06	0.71	23.72	23.48	17.02
Site Prep and Foundation	Concrete Saw	Other Construction Equipment	50	1	120	10	1200	0.03	0.25	0.18	0.00	0.02	0.01	39.76	296.32	217.33	0.47	18.27	18.09	11.24
Site Prep and Foundation	Crane	Crane	Comp	1	120	4	480	0.05	0.40	0.72	0.00	0.03	0.04	25.23	191.12	347.69	0.70	16.02	15.86	16.97
Site Prep and Foundation	Drill Rig Large	Drill Rig (Mobile)	Comp	1	120	10	1200	0.08	0.50	1.06	0.00	0.04	0.07	95.95	601.12	1277.60	3.33	50.28	49.78	80.22
Site Prep and Foundation	Excavator	Excavator	Comp	1	120	20	2400	0.02	0.51	0.31	0.00	0.01	0.03	59.64	1233.50	744.74	3.20	31.05	30.74	77.09
Site Prep and Foundation	Forklift	Forklft	Comp	1	120	20	2400	0.02	0.22	0.17	0.00	0.01	0.01	40.09	519.84	416.84	0.96	29.80	29.50	23.02
Site Prep and Foundation	Front End Loader	Rubber Tired Loaders	Comp	1	120	20	2400	0.05	0.44	0.60	0.00	0.03	0.04	113.60	1064.52	1440.85	3.86	64.51	63.87	92.88
Site Prep and Foundation	Generator	Other Industrial Equipment	50	2	120	20	4800	0.02	0.22	0.13	0.00	0.01	0.01	109.33	1058.89	610.11	1.41	47.44	46.96	34.04
Site Prep and Foundation	Light Plants	Other Industrial Equipment	50	2	120	10	2400	0.02	0.29	0.13	0.00	0.01	0.01	54.66	693.65	305.06	0.71	23.72	23.48	17.02
Site Prep and Foundation	Welding Machine	Other Construction Equipment	50	0	120	0	0	0.03	0.23	0.18	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Equipment Installation	Aerial Lift	Aerial Lift	Comp	0	140	0	0	0.00	0.17	0.10	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Equipment Installation	Backhoe	Tractors/Loaders/Backhoes	Comp	0	140	0	0	0.02	0.36	0.27	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Equipment Installation	Compressor	Other Industrial Equipment	50	0	140	0	0	0.02	0.21	0.13	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Equipment Installation	Concrete Saw	Other Construction Equipment	50	3	140	4	1680	0.03	0.25	0.18	0.00	0.02	0.01	55.67	414.84	304.27	0.65	25.57	25.32	15.74
Equipment Installation	Crane	Crane	Comp	0	140	0	0	0.05	0.40	0.72	0.00	0.03	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Equipment Installation	Drill Rig Large	Drill Rig (Mobile)	Comp	0	140	0	0	0.08	0.50	1.06	0.00	0.04	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Equipment Installation	Excavator	Excavator	Comp	2	140	20	5600	0.02	0.51	0.31	0.00	0.01	0.03	139.17	2878.17	1737.72	7.47	72.46	71.73	179.87
Equipment Installation	Forklift	Forklft	Comp	0	140	0	0	0.02	0.22	0.17	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Equipment Installation	Front End Loader	Rubber Tired Loaders	Comp	2	140	20	5600	0.05	0.44	0.60	0.00	0.03	0.04	265.08	2483.89	3361.98	9.00	150.53	149.02	216.71
Equipment Installation	Generator	Other Industrial Equipment	50	4	140	10	5600	0.02	0.22	0.13	0.00	0.01	0.01	127.55	1235.37	711.80	1.65	55.34	54.79	39.72
Equipment Installation	Light Plants	Other Industrial Equipment	50	1	140	20	2800	0.02	0.29	0.13	0.00	0.01	0.01	63.77	809.26	355.90	0.82	27.67	27.39	19.86
Equipment Installation	Welding Machine	Other Construction Equipment	50	5	140	20	14000	0.03	0.23	0.18	0.00	0.02	0.01	463.89	3179.98	2535.57	5.44	213.12	210.99	131.16
QA/QC	Aerial Lift	Aerial Lift	Comp	0	20	0	0	0.00	0.17	0.10	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
QA/QC	Backhoe	Tractors/Loaders/Backhoes	Comp	0	20	0	0	0.02	0.36	0.27	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
QA/QC	Compressor	Other Industrial Equipment	50	0	20	0	0	0.02	0.21	0.13	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
QA/QC	Concrete Saw	Other Construction Equipment	50	1	20	4	80	0.03	0.25	0.18	0.00	0.02	0.01	2.65	19.75	14.49	0.03	1.22	1.21	0.75
QA/QC	Crane	Crane	Comp	0	20	0	0	0.05	0.40	0.72	0.00	0.03	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
QA/QC	Drill Rig Large	Drill Rig (Mobile)	Comp	0	20	0	0	0.08	0.50	1.06	0.00	0.04	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
QA/QC	Excavator	Excavator	Comp	2	20	10	400	0.02	0.51	0.31	0.00	0.01	0.03	9.94	205.58	124.12	0.53	5.18	5.12	12.85
QA/QC	Forklift	Forklft	Comp	0	20	0	0	0.02	0.22	0.17	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
QA/QC	Front End Loader	Rubber Tired Loaders	Comp	0	20	0	0	0.05	0.44	0.60	0.00	0.03	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
QA/QC	Generator	Other Industrial Equipment	50	2	20	10	400	0.02	0.22	0.13	0.00	0.01	0.01	9.11	88.24	50.84	0.12	3.95	3.91	2.84
QA/QC	Light Plants	Other Industrial Equipment	50	1	20	10	200	0.02	0.29	0.13	0.00	0.01	0.01	4.56	57.80	25.42	0.06	1.98	1.96	1.42
QA/QC	Welding Machine	Other Construction Equipment	50	1	20	20	400	0.03	0.23	0.18	0.00	0.02	0.01	13.25	90.86	72.44	0.16	6.09	6.03	3.75
Tie-in	Aerial Lift	Aerial Lift	Comp	0	10	0	0	0.00	0.17	0.10	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tie-in	Backhoe	Tractors/Loaders/Backhoes	Comp	1	10	24	240	0.02	0.36	0.27	0.00	0.02	0.02	5.46	87.12	65.74	0.19	3.92	3.88	4.60
Tie-in	Compressor	Other Industrial Equipment	50	0	10	0	0	0.02	0.21	0.13	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tie-in	Concrete Saw	Other Construction Equipment	50	3	10	4	120	0.03	0.25	0.18	0.00	0.02	0.01	3.98	29.63	21.73	0.05	1.83	1.81	1.12
Tie-in	Crane	Crane	Comp	0	10	0	0	0.05	0.40	0.72	0.00	0.03	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tie-in	Drill Rig Large	Drill Rig (Mobile)	Comp	0	10	0	0	0.08	0.50	1.06	0.00	0.04	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tie-in	Excavator	Excavator	Comp	2	10	24	480	0.02	0.51	0.31	0.00	0.01	0.03	11.93	246.70	148.95	0.64	6.21	6.15	15.42
Tie-in	Forklift	Forklft	Comp	0	10	0	0	0.02	0.22	0.17	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tie-in	Front End Loader	Rubber Tired Loaders	Comp	0	10	0	0	0.05	0.44	0.60	0.00	0.03	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tie-in	Generator	Other Industrial Equipment	50	4	10	12	480	0.02	0.22	0.13	0.00	0.01	0.01	10.93	105.89	61.01	0.14	4.74	4.70	3.40
Tie-in	Light Plants	Other Industrial Equipment	50	0	10	0	0	0.02	0.29	0.13	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tie-in	Welding Machine	Other Construction Equipment	50	2	10	24	480	0.03	0.23	0.18	0.00	0.02	0.01	15.90	109.03	86.93	0.19	7.31	7.23	4.50
Total Emissions for Construction of Two ESPs (tons)														**0.9**	**9.5**	**8.0**	**0.0**	**0.5**	**0.5**	**1069.2**
Site Prep and Foundation (Peak Daily Emissions lb/day)														**5.4**	**58.6**	**52.7**	**0.1**	**2.9**	**2.8**	**3.5**
Equipment Installation (Peak Daily Emissions lb/day)														**8.0**	**78.6**	**64.3**	**0.2**	**3.9**	**3.9**	**4.3**
QA/QC (Peak Daily Emissions lb/day)														**2.0**	**23.1**	**14.4**	**0.0**	**0.9**	**0.9**	**1.1**
Tie-in (Peak Daily Emissions lb/day)														**4.8**	**57.8**	**38.4**	**0.1**	**2.4**	**2.4**	**2.9**

Notes:

(1) Off-Road 2011 for 2019 fleet. CO emissions from SCAQMD, 2006 : http://www.aqmd.gov/ceqa/handbook/offroad/offroadEF07_25.xls

(2) Carbon Dioxide Equivalents (CO2e) are based on fuel use and default emission factors for diesel. Metric tons.

(3) Equipment list and schedule from FEIR for Exxon Mobil Rule 1105.1 Compliance Project (SCAQMD 2007). Equipment installation phase duration scaled by half for one ESP instead of two.

Appendix B
Expedited BARCT Implementation Schedule
ESP Construction Emission Summary

ACTIVITY	ROG	CO	NOx	SOx	PM10	PM2.5	CO2e
Peak Daily Emissions (lb/day)							
Site Prep and Foundation	5.64	63.56	57.66	0.17	4.67	3.44	5.10
Equipment Installation	8.09	83.60	65.17	0.20	4.85	4.27	5.49
QA/QC	2.02	24.43	14.75	0.05	1.20	1.03	1.41
Tie-in	4.90	60.48	39.20	0.13	2.96	2.62	3.56
Total Emissions (tons)							
Construction Activities for One ESP(1)	0.96	10.56	8.42	0.03	0.71	0.56	1075.77

(1) Assumes 14 months of construction.

Appendix B
Expedited BARCT Implementation Schedule
ESP On-road Construction Emissions

Phase	Vehicle	Trip Length	Total Trips	VMT	VOC (lb/mi)	CO (lb/mi)	NOx (lb/mi)	SOx (lb/mi)	PM (lb/mi)	Fugitive PM	CO2e (lb/mile)	VOC (lbs)	CO (lbs)	NOx (lbs)	SOx (lbs)	PM10 (lbs)	PM2.5 (lbs)	CO2e (tonnes)
Site Prep and Foundation	Commuters	24.8	11400	282720	0.000	0.002	0.000	0.000	0.000	0.000	0.895	12.14	486.48	78.18	2.00	92.64	40.78	114.76
Site Prep and Foundation	Delivery	40	5	200	0.000	0.002	0.007	0.000	0.000	0.000	2.243	0.08	0.38	1.33	0.01	0.19	0.11	0.20
Site Prep and Foundation	HHDT	40	1200	48000	0.000	0.002	0.011	0.000	0.000	0.002	3.742	16.91	110.79	517.29	1.68	123.90	31.69	81.47
Equipment Installation	Commuters	24.8	32900	815920	0.000	0.002	0.000	0.000	0.000	0.000	0.895	35.03	1403.97	225.62	5.78	267.36	117.68	331.20
Equipment Installation	Delivery	40	15	600	0.000	0.002	0.007	0.000	0.000	0.000	2.243	0.25	1.14	3.99	0.02	0.57	0.34	0.61
Equipment Installation	HHDT	40	5	200	0.000	0.002	0.011	0.000	0.000	0.002	3.742	0.07	0.46	2.16	0.01	0.52	0.13	0.34
QA/QC	Commuters	24.8	600	14880	0.000	0.002	0.000	0.000	0.000	0.000	0.895	0.64	25.60	4.11	0.11	4.88	2.15	6.04
QA/QC	Delivery	40	5	200	0.000	0.002	0.007	0.000	0.000	0.000	2.243	0.08	0.38	1.33	0.01	0.19	0.11	0.20
QA/QC	HHDT	40	5	200	0.000	0.002	0.011	0.000	0.000	0.002	3.742	0.07	0.46	2.16	0.01	0.52	0.13	0.34
Tie-in	Commuters	24.8	600	14880	0.000	0.002	0.000	0.000	0.000	0.000	0.895	0.64	25.60	4.11	0.11	4.88	2.15	6.04
Tie-in	Delivery	40	5	200	0.000	0.002	0.007	0.000	0.000	0.000	2.243	0.08	0.38	1.33	0.01	0.19	0.11	0.20
Tie-in	HHDT	40	5	200	0.000	0.002	0.011	0.000	0.000	0.002	3.742	0.07	0.46	2.16	0.01	0.52	0.13	0.34
Total Emissions (tons)												**0.03**	**1.03**	**0.42**	**0.00**	**0.25**	**0.10**	**6.58**
Site Prep and Foundation (Peak Daily Emissions lb/day)												**0.24**	**4.98**	**4.97**	**0.03**	**1.81**	**0.60**	**1.64**
Equipment Installation (Peak Daily Emissions lb/day)												**0.13**	**5.02**	**0.83**	**0.02**	**0.96**	**0.42**	**1.19**
QA/QC (Peak Daily Emissions lb/day)												**0.04**	**1.32**	**0.38**	**0.01**	**0.28**	**0.12**	**0.33**
Tie-in (Peak Daily Emissions lb/day)												**0.08**	**2.64**	**0.76**	**0.01**	**0.56**	**0.24**	**0.66**

Notes:

(1) Peak day assumes 20 workers per day and all deliverise occur in one day. Project emissiosn based on 20 commuters per day for 20 days.

(2) Emfac2014 emission factors for the San Francisco Bay Area District for 2019 fleet.

(3) Fugitive PM emission calculations for travel on paved roads from EPA AP-42 Section 13.2.1, January 2011

$E = k(sL)^{0.91} \times (W)^{1.02}$

Where: k = 0.0022 lb/VMT for PM10, sL = road silt loading (gms/m2)

(0.03 for major/collector roads), W = weight of vehicles (2.5 tons for light; 5.5 for medium trucks,

and 24 for heavy trucks)

(4) Carbon Dioxide Equivalence (CO_E) = CO_2 + CH_4 * 21 + N2O*310

where CO2 emissions factors are from Emfac2011. CH4 and N2O emissions factors are from Direct Emissions from Mobile Combustion Sources, EPA 2008.

where light vehicle are gasoline light duty trucks.

where medium/heavy duty vehicle are diesel heavy duty trucks.

	2019		
Chemical	**Light**	**Medium**	**Heavy**
CO2 (lb/mi)	0.8949	2.2430	3.7418
CH4 (g/mi)	0.0148	0.0051	0.0051
N2O (g/mi)	0.0157	0.0048	0.0048
CO2e (lb/mi)	0.906	2.247	3.745

(5) Equipment list and schedule from FEIR for Exxon Mobil Rule 1105.1 Compliance Project (SCAQMD 2007). Equipment installation phase duration scaled by half for one ESP instead of two.

Appendix B
Expedited BARCT Implementation Schedule
Oxidizer Construction Emission Summary

ACTIVITY[1]	ROG	CO	NOx	SOx	PM10	PM2.5	CO2e (MT)
Peak Daily Emissions (lb/day)							
Construction Activities for 1 Oxidizer	0.03	0.35	0.45	<0.01	0.15	0.07	0.57
Overlapping Construction Emissions for 5 Oxidizers	0.15	1.75	2.25	<0.01	0.75	0.35	2.87
Total Emissions (tons)							
Construction Activities for 1 Oxidizer[2]	<0.001	0.004	0.005	<0.001	0.002	0.001	12.07
Construction Emissions for 15 Oxidizers	0.005	0.055	0.071	<0.01	0.024	0.011	180.98

Notes:

(1) Emissions from Final Program EA for Proposed Amended Regulation XX - (RECLAIM) (SCAQMD 2015)

(2) Assumes 21 days of contruction.

Appendix B
Expedited BARCT Implementation Schedule
Lime Injector Construction Emission Summary

ACTIVITY(1)	ROG	CO	NOx	SOx	PM10	PM2.5	CO2e (MT)
Peak Daily Emissions (lb/day)							
Construction Activities for Lime Injector	0.03	0.35	0.45	<0.01	0.15	0.07	0.57
Total Emissions (tons)							
Construction Activities for Lime Injector(2)	<0.001	0.004	0.005	<0.001	0.002	0.001	12.07

Notes:

(1) Emissions from Final Program EA for Proposed Amended Regulation XX - (RECLAIM) (SCAQMD 2015). Assumes similar emissions to oxidizer construction.

(2) Assumes 21 days of contruction.

Appendix B
Expedited BARCT Implementation Schedule
WGS Construction Emission Summary

ACTIVITY[1]	ROG	CO	NOx	SOx	PM10	PM2.5	CO2e
Peak Daily Emissions (lb/day)							
Demolition	6.00	36.00	28.00	<1	3.00	2.00	--
Construction	17.00	67.00	84.00	<1	39.00	23.00	--
Total Emissions (tons)							
Demolition[2]	0.06	0.36	0.28	<0.1	0.03	0.02	--
Construction[3]	2.04	8.04	10.08	<0.1	4.68	2.76	--
Total Construction Emissions	2.10	8.40	10.36	<0.1	4.71	2.78	468.00

Notes:

(1) Emissions from FEIR for ConocoPhillips Los Angeles Refinery PM10 and Nox Reduction Projects (SCAQMD 2007)

(2) Demolition activities include off-road construction equipment and on-road mobile source emissions and are estimated to occur for one month (20 working days)

(3) Construction activities include off-road construction equipment and on-road mobile source emissions and are estimated to occur for a total of 16 months (20 working days per month), with 8 months at peak construction activities and 8 months at 50 percent of peak construction activities.

Appendix B
Expedited BARCT Implementation Schedule
LoTox Scrubber Construction Emission Summary

ACTIVITY[1]	ROG	CO	NOx	SOx	PM10	PM2.5	CO2e
Peak Daily Emissions (lb/day)							
Demolition	6.00	36.00	28.00	<1	3.00	2.00	--
Construction	17.00	67.00	84.00	<1	39.00	23.00	--
Total Emissions (tons)							
Demolition[2]	0.06	0.36	0.28	<0.1	0.03	0.02	--
Construction[3]	2.04	8.04	10.08	<0.1	4.68	2.76	--
Total Construction Emissions	2.10	8.40	10.36	<0.1	4.71	2.78	468.00

Notes:

(1) Emissions from FEIR for ConocoPhillips Los Angeles Refinery PM10 and Nox Reduction Projects (SCAQMD 2007)

(2) Demolition activities include off-road construction equipment and on-road mobile source emissions and are estimated to occur for one month (20 working days)

(3) Construction activities include off-road construction equipment and on-road mobile source emissions and are estimated to occur for a total of 16 months (20 working days per month), with 8 months at peak construction activities and 8 months at 50 percent of peak construction activities.

Appendix B
Expedited BARCT Implementation Schedule
SCR Constrution Emissions Summary

ACTIVITY[1]	ROG	CO	NOx	SOx	PM10	PM2.5	CO2e
Peak Daily Emissions (lb/day)							
Off-road Construction Emissions	1.86	12.02	14.94	0.00	4.12	3.79	--
On-road Vehicle Trip Emissions	5.22	8.58	8.6	0.71	0.47	0.22	--
Total Construction Emissions	7.08	20.6	23.54	0.71	4.59	4.01	--
Annual Emissions (tons/yr)							
Construction for One SCR [2]	0.69	3.18	3.75	0.07	0.85	0.76	574

Notes:

(1) Emissions from Final Program EA for Proposed Amended Regulation XX - (RECLAIM) (SCAQMD 2015)

(2) Assumes 12 months of contruction.

Appendix B
Expedited BARCT Implementation Schedule
Operation Emissions from Thermal Oxidizer

Parameter [1]	**VOC**	**CO** [2]	**NOx** [3]	**SOx**	**PM10**	**PM2.5**	**CO_2**	**N_2O**	**CH_4**	**CO2e**
Emission Factor[4]	7.00	0.30	0.04	0.60	7.50	7.50	120000.00	0.64	2.30	120246.70
Emission Factor Units	lb/mmscf	lb/mmbtu	lb/mmbtu	lb/mmscf	lb/mmscf	lb/mmscf	lb/mmscf	lb/mmscf	lb/mmscf	lb/mmscf
Heater Duty mmbtu/hr	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Heating Value (btu/scf)	1050.00	1050.00	1050.00	1050.00	1050.00	1050.00	1050.00	1050.00	1050.00	1050.00
Fuel Use (mmscf/yr)	25	25	25	25	25	25	25	25	25	25
Operational Time (hr/day)	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Daily Emissions (lb)	**0.16**	**7.10**	**0.88**	**0.01**	**0.17**	**0.17**	**2742.86**	**0.01**	**0.05**	**2748.50**
Daily Total for 15 Oxidizers (lb)	**2.40**	**106.56**	**13.13**	**0.21**	**2.57**	**2.57**	**41142.86**	**0.22**	**0.79**	**41227.44**
Annual Emissions (tons or MT for GHG Emissions)	**0.03**	**1.30**	**0.16**	**0.00**	**0.03**	**0.03**	**454.12**	**0.00**	**0.01**	**455.05**
Annual Emissions for 15 Oxidizers (tons or MT for GHG Emissions)	**0.44**	**19.45**	**2.40**	**0.04**	**0.47**	**0.47**	**6811.73**	**0.04**	**0.13**	**6825.74**

Note:

(1) Detailed calculations can be found in BAAQMD, 2016, Appendix A.

(2) Based on 400 ppm

(3) Based on 30 ppm

(4) Default emission factors for natural gas combustion for external combustion sources. SCAQMD Annual Emissions Reporting and AP-42 for GHG emissions.

Appendix B
Expedited BARCT Implementation Schedule
Operational Delivery Truck Emissions

Equipment	Vehicle	Trip Length	Total Trips	VMT	VOC (lb/mi)	CO (lb/mi)	NOx (lb/mi)	SOx (lb/mi)	PM (lb/mi)	Fugitive PM	CO2e (lb/mile)	VOC (lbs)	CO (lbs)	NOx (lbs)	SOx (lbs)	PM10 (lbs)	PM2.5 (lbs)	CO2e (MT)
Caustic/Catalyst for 1 WGS	HHDT	120	104	12480	0.00035	0.00231	0.01078	0.00004	0.00027	0.00231	3.745	4.397	28.805	134.496	0.437	32.213	8.241	21.202
Caustic/Catalyst for 1 LoTox Scrubber	HHDT	120	104	12480	0.00035	0.00231	0.01078	0.00004	0.00027	0.00231	3.745	4.397	28.805	134.496	0.437	32.213	8.241	21.202
Lime for Cement Kiln	HHDT	100	365	36500	0.00035	0.00231	0.01078	0.00004	0.00027	0.00231	3.745	12.860	84.246	393.357	1.279	94.212	24.101	62.008
Annual Emissions (tons/yr)												**0.05**	**0.08**	**0.48**	**0.05**	**0.13**	**0.05**	**146.82**
Peak Daily (lb/day)												**0.39**	**2.66**	**12.52**	**0.05**	**0.29**	**0.09**	**0.58**

Notes:

(1) Peak day assumes 3 caustic delivery trucks for WGS, 1 caustic delivery truck for LoTOx, and 1 lime delivery truck.

(2) Emfac2014 emission factors for the San Francisco Bay Area District for 2019 fleet.

(3) Fugitive PM emission calculations for travel on paved roads from EPA AP-42 Section 13.2.1, January 2011

$E = k(sL)^{0.91} \times (W)^{1.02}$

Where: k = 0.0022 lb/VMT for PM10, sL = road silt loading (gms/m2)

(0.03 for major/collector roads), W = weight of vehicles (2.5 tons for light; 5.5 for medium trucks,

and 24 for heavy trucks)

(4) Carbon Dioxide Equivalence (CO_E) = CO_2 + CH_4 * 21 + N2O*310

where CO2 emissions factors are from Emfac2011. CH4 and N2O emissions factors are from Direct Emissions from Mobile Combustion Sources, EPA 2008.

where light vehicle are gasoline light duty trucks.

where medium/heavy duty vehicle are diesel heavy duty trucks.

Chemical	2019 Light	2019 Medium	2019 Heavy
CO2 (lb/mi)	0.8949	2.2430	3.7418
CH4 (g/mi)	0.0148	0.0051	0.0051
N2O (g/mi)	0.0157	0.0048	0.0048
CO2e (lb/mi)	0.906	2.247	3.745

Daily Peak Emissions (lbs/day)	VOC (lbs)	CO (lbs)	NOx (lbs)	SOx (lbs)	PM10 (lbs)	PM2.5 (lbs)	CO2e (MT)
Caustic/Catalyst for 1 WGS	0.08	0.55	2.59	0.01	0.06	0.02	898.86
Caustic/Catalyst for 1 LoTox Scrubber	0.08	0.55	2.59	0.01	0.06	0.02	898.86
Lime for Cement Kiln	0.07	0.46	2.16	0.01	0.05	0.01	749.05

Annual Emissions (tons/yr)	VOC (lbs)	CO (lbs)	NOx (lbs)	SOx (lbs)	PM10 (lbs)	PM2.5 (lbs)	CO2e (MT)
Caustic/Catalyst for 1 WGS	0.00	0.01	0.07	0.00	0.02	0.00	0.01
Caustic/Catalyst for 1 LoTox Scrubber	0.00	0.01	0.07	0.00	0.02	0.00	0.01
Lime for Cement Kiln	0.01	0.04	0.20	0.00	0.05	0.01	0.03

Appendix B
Expedited BARCT Implementation Schedule
GHG Emissions from Electricity

Control Equipment	Number of Units	Potential Increased Electricity Demand (MWhr/yr)	Emission Factor (lb/MWhr) (1)	Emissions (CO2e MT/yr)
WGS(2)	1	261	644	76.24
LoTox Scrubber(2)	1	261	644	76.24
SCR(3)	1	222	644	64.82
ESP(4)	2	803	644	234.57
			Total Emissions	451.87

(1) CAPCOA, 2016. Based on PG&E emission factors from CalEEMod.

(2) FEIR for ConocoPhillips Los Angeles Refinery PM10 and Nox Reduction Projects (SCAQMD 2007)

(3) Final Program EA for Proposed Amended Regulation XX - (RECLAIM) (SCAQMD 2015)

(4) FEIR for Exxon Mobil Rule 1105.1 Compliance Project (SCAQMD 2007)

Appendix B
Expedited BARCT Implementation Schedule
Scrubber TAC Emissions

Pollutant	Daily Usage (tons/day)	Annual Usage (tons/day)	Usage Rate (gal/day)	Density (lb/gal)	Daily Usage (lb/day)
NaOH (50% solution)	3.37	1228.30	22.00	12.747	280.43

NaOH Demand Filling Loss (lb/day)	Q = Fill Rate = NaOH Demand (MMgal/day)	S = Saturation Factor	P = Vapor Pressure of material Loaded (psia)	M = NaOH vapor molecular weight (lb/lbmole)	T= temperature of liquid loaded (oR)	Daily PM10 Filling Loss (lb/day)	Eworking = Hourly PM10 Working Loss (lb/hr)	Total Hourly PM10 Loss (lb/hr)	Total Hourly PM10 Loss (lb/hr) at 25m
3.37	0.53	1.45	0.042	24.8	544.67	1.82E-02	7.60E-04	2.28E-03	2.28E-05

NaOH @ 50% solution density = 12.747 lb/gal

Mv for NaOH solution = 24.8 lb/lbmol

Vapor Pressure for NaOH = 2.18 mmHg at 29.4oC or 85oF = 0.042 psia

Loading Temperature = 85^{o}F to 100^{o}F (544.67^{o}R to 559.67^{o}R)

Breathing Loss = 3 * Filling Loss

Filling Loss

$E_{loading}$ lb/day = (12.46) ((S)(P)(M)(Q))/T where:

S = saturation factor (dimensionless; obtained from Table 5.2-1 in AP-42)

= 1.45 (Splash loading: dedicated normal service)

P = vapor pressure of the material loaded at temperature T (psia)

M = vapor molecular weight (lb/lb-mole)

Q = volume of material loaded (1,000 gal/day)

T = temperature of liquid loaded (^{o}R).

Summary of Comments and Response on the Regulatory Package for Proposed Amendments to Regulation 6, Rule 5: Particulate Emissions from Refinery Fluidized Catalytic Cracking Units

Table of Contents

List of Commenters

The following table lists the individuals and organizations from whom Air District staff received written comments prior to the April 30, 2021 comment deadline.

Abbreviation	Commenter / Reference
350 Bay Area	Jed Holtzman Senior Policy Analyst 350 Bay Area Letter, April 28, 2021
A. C. Mogal	Amy Cecilia Mogal, MD/PhD Clinical Instructor, Stanford University School of Medicine; Department of Anesthesiology and Perioperative Medicine Attending Physician, Washington Hospital, Intensive Care Unit Email, April 29, 2021
A. Millstein	Amanda Millstein, MD Resident/Physician Email, April 30, 2021
A. van Nieuwenhuizen	Adrienne van Nieuwenhuizen, MD Resident/Physician Email, April 30, 2021
Airlines for America	Sean Williams Vice-President, State and Local Government Affairs Airlines for America Letter, April 30, 2021
B. Andrews	Bret Andrews Resident/Neurologist Email, April 27, 2021
B. Lindblom	Brian Lindblom Resident Email, April 27, 2021
CBE	Dan Sakaguchi, CBE Staff Researcher Sharifa Taylor, CBE Staff Researcher Connie Cho, CBE Legal Tyler Earl, CBE Staff Attorney Andrés Soto, CBE Richmond Organizer Zolboo Namkhaidorj, CBE Richmond Youth Organizer Ernesto Arevalo, CBE Northern California Program Director Communities for a Better Environment Letter, April 30, 2021
CCEEB	Bill Quinn President California Council for Environmental and Economic Balance Letter, April 30, 2021
Chevron	Michael Carroll Latham & Watkins, LLP Letter, April 30, 2021

Abbreviation	Commenter / Reference
Climate Health Now (AM)	Ashley McClure, MD Physician and Co-Founder Climate Health Now Email, April 28, 2021
Climate Health Now (CM)	Cynthia Mahoney, MD Advocate for the Medical Society Consortium for Climate & Health Clinical Associate Professor of Medicine, Stanford University (ret.) Climate Health Now Email, April 30, 2021
Community Energy reSource	Greg Karras Community Energy resource Letter, April 30, 2021
D. Bezanson	David Bezanson, Ph.D. Resident Email, April 27, 2021
EBLC	Kristin Connelly President & CEO East Bay Leadership Council Letter, April 27, 2021
IACCC	Mark Hughes Executive Director The Industrial Association of Contra Costa County Letter, April 26, 2021
J. Kilbreth	Jeffrey Kilbreth Richmond-San Pablo CERP Steering Committee Email, April 14, 2021
J. Mann	Jeffrey Mann, MD Resident/Physician Email, April 28, 2021
J. Perlman	Janet Perlman, MC, MPH Resident/Pediatrician Email, April 28, 2021
Jane G	Jane G Resident Letter, May 4, 2021
K. Maher	Karina Maher, MD Resident/Pediatrician Email, April 20, 2021
M. Graubard	Moses Graubard, MD Resident/Physician Email, April 28, 2021
M. Whitman	Meg Whitman, MD Resident/Physician Email, April 30, 2021
Martinez Chamber	Julie Johnston President/CEO Martinez Chamber of Commerce Letter, April 27, 2021

Abbreviation	Commenter / Reference
Mayor of Martinez	Rob Schroder, Mayor City of Martinez Letter, April 28, 2021
Montrose AQS	Kevin Crosby Montrose Air Quality Services
P. Bentom	Paul Bentom Individual Letter, May 4, 2021
PBF (AN)	Andres Novoa Operations Support Engineer PBF Martinez Refinery Company Email, April 26, 2021
PBF (BN1)	Brian Nippa Sr. Engineer, Project Development PBF Martinez Refinery Company Letter, April 14, 2021
PBF (BN2)	Brian Nippa Sr. Engineer, Project Development PBF Martinez Refinery Company Letter, April 29, 2021
PBF (DB)	Dave Bleckinger Manager, Reliability Rotating & Electrical PBF Martinez Refinery Company Email, April 16, 2021
PBF (HD)	Harry Dhillon Process Engineer PBF Martinez Refinery Company Email, April 21, 2021
PBF (JF)	Jerry Forstell Refinery Manager PBF Martinez Refinery Company Letter, April 30, 2021
PBF (JS)	Jessica Scheiber LOP Environmental Focal Point PBF Martinez Refinery Company Email, April 22, 2021
PBF (ML)	Meredith Lewis Process Safety and Assurance Department PBF Martinez Refinery Company Letter, April 14, 2021
PBF (PO)	Patrick Owens Safety Engineer PBF Martinez Refinery Company Letter, April 29, 2021
PBF (RM)	Captain Roy M. Mathur Wharf Master PBF Martinez Refinery Company Letter, April 13, 2021

Abbreviation	Commenter / Reference
PBF (SN)	Susan Nelson Health, Safety, Security and Environmental Manager PBF Martinez Refinery Company Letter, April 19, 2021
PBF Energy	Timothy Paul Davis Western Region President PBF Energy Letter, April 29, 2021
R. Rosenbaum	Robert Rosenbaum, Ph.D. Resident/Neuropsychologist Email, April 28, 2021
S. Oh	Sally Oh M.D. Candidate UCSF School of Medicine Email, April 28, 2021
S. Rosenblum	Dr. Stephen S. Rosenblum, Ph.D. Resident Letter, March 30, 2021
SFO	Ivar Satero San Francisco International Airport Letter, April 12, 2021
T. McCarthy	Theresa McCarthy Individual Letter, May 4, 2021
Valero	Taryn Wier Manager – Environmental Engineering Valero Benicia Refinery Letter, April 30, 2021
WSPA	Kevin Buchan Senior Manager, Bay Area Region Western States Petroleum Association Letter, April 30, 2021

General Comments

Support for proposed amendments

Comment: Several commenters expressed support for proposed amendments to achieve associated health benefits.

350 Bay Area, A. C. Mogal, A. Millstein, A. van Nieuwenhuizen, B. Andrews, Climate Health Now (AM), Climate Health Now (CM), Community Energy reSource, D. Bezanson, J. Kilbreth, J. Mann, J. Perlman, K. Maher, M. Graubard, M. Whitman, R. Rosenbaum, S. Oh, S. Rosenblum

Response: The Air District appreciates the comments in support of the proposed amendments.

Support for consideration of other options

Comment: Several commenters expressed support for other control options instead of the proposed amendments. Several commenters stated that a less stringent PM limit of 0.020 gr/dscf, with flexibility as to how this would be met by each facility, would allow refining operations to remain economically feasible and still achieve substantial emission reductions.

EBLC, Martinez Chamber, Mayor of Martinez, PBF (HD), PBF (JS), PBF (ML), PBF (PO), PBF Energy, IACCC

Response: Information on the other potential control options identified and evaluated is included in the Staff Report. The Air District believes discussion of both control options will promote a more informed decision by the Board of Directors and a better understanding by the public.

Control options less stringent than the proposed amendments would not meet the legal definition of BARCT

Comment: Commenters stated that AB 617 mandates the Best Available Retrofit Control Technology, and any control option less stringent than the proposed amendments would not meet this legal requirement.

350 Bay Area, CBE

Response: Best Available Retrofit Control Technology (BARCT) is defined in the California Health and Safety Code as an emission limitation that is based on the maximum degree of reduction achievable, taking into account environmental, energy, and economic impacts by each class or category of source. The California Health and Safety Code requires that multiple impacts be taken into account and does not mandate that a specific level of control constitute BARCT. Furthermore, under California Health and Safety Code Section 40920.6, a district may establish its own best available retrofit control technology requirement based upon consideration of the factors specified in the BARCT definition.

Cost-Effectiveness and Incremental Cost-Effectiveness

Cost-effectiveness and incremental cost-effectiveness have not been properly considered and are not supported

Comment: Several commenters stated that the Air District has not conducted the required cost-effectiveness analysis in a robust, transparent, or accurate way as required by California law, and the cost per ton is underestimated due to underestimated costs and overestimated emission reductions. Commenters stated that the Best Available Retrofit Control Technology is required to be cost-effective, and the proposed amendments do not meet this criterion. Commenters stated that the cost per ton of the proposed amendments is substantially higher than other adopted Air District rules, and one commenter stated that costs exceed a cost-effectiveness threshold set by the South Coast AQMD.

Several commenters also stated that the Air District has not considered incremental cost-effectiveness of other control options as required by the California Health and Safety Code, and has not explained how cost-effectiveness and incremental cost-effectiveness were considered in the determination of the recommended controls. Commenters asserted that the cost-effectiveness of the proposed amendments is not reasonable and that costs outweigh the health benefits.

CCEEB, Chevron, PBF (JF), PBF Energy, WSPA

Response: Cost-effectiveness is a required consideration for the adoption the proposed amendments. Best Available Retrofit Control Technology (BARCT) is defined in the California Health and Safety Code as an emission limitation that is based on the maximum degree of reduction achievable, taking into account environmental, energy, and economic impacts by each class or category of source. The Staff Report includes the required analysis of cost impacts and cost-effectiveness. The California Health and Safety Code requires that cost-effectiveness and economic impacts be considered but does not require a finding that a rule is cost effective, nor does State law require that an air district adopt a quantitative definition of cost effectiveness. Cost effectiveness estimates for previously adopted rules provide useful context but do not limit the Air District's authority in adopting future rules or amendments.

The South Coast AQMD reported cost-effectiveness threshold cited by one commenter is specifically for use with South Coast AQMD's BACT Guidelines in their New Source Review process. These BACT guidelines would not limit South Coast AQMD's authority in adopting a rule, and so of course would likewise not affect the authority of any other air district.

Incremental cost-effectiveness of different control options is a required consideration for the adoption of the proposed amendments, and is included in the Staff Report. The Air District is required to evaluate incremental cost-effectiveness but is not required to make a finding in that regard. The Staff Report evaluates the incremental cost-effectiveness of both control options (ESPs and wet gas scrubbers) that have been considered during development of Rule 6-5 amendments.

The Staff Report explains why, although the cost-effectiveness and incremental cost-effectiveness values of the proposed amendments are higher than previously adopted Air District rules, adoption of the proposed amendments is nevertheless justified.

Additionally, information on potential health benefits and valuation of the proposed amendments have been included in the Staff Report to allow a more informed decision by the Board of Directors and a better understanding by the public. The California Health and Safety Code does not require the calculation of these health benefits, and does not require that calculated health benefits meet a particular threshold or value.

Cost Estimates

Compliance costs are underestimated

Comment: Several commenters stated that cost estimates developed by staff for the proposed amendments are underestimated. Several commenters claimed that cost estimates and information provided by industry have been ignored. Commenters asserted that other cost estimate information or methods should be used, including more appropriate cost indices for escalation at California refineries (such as the IHS Markit Downstream Capital Costs Index and Nelson Farrar Cost Index), and an independent assessment for actual expected costs.

One commenter stated that staff have ignored the cost data from the installation of a wet gas scrubber at the Valero Benicia Refinery, while another commenter questioned why the cost estimates for the proposed amendments are lower than the cost of the wet gas scrubber at the Valero Benicia Refinery. Commenters stated that cost data of other installations cited by staff do not contain enough information to determine whether the costs were the costs of the scrubbers or the total cost of all modifications needed as a result of installing the scrubbers. Some commenters asserted that because some wet gas scrubbers at FCCUs do not meet the proposed limits, the costs are not applicable and the Air District must be underestimating the costs of achieving compliance.

Commenters stated that cost estimates should assume that water resources impacts will be mitigated, and that cost estimates should be higher as a result. One commenter also stated that the cost estimates do not account for increased project and labor costs due to health mandates associated with the COVID-19 pandemic.

CCEEB, Chevron, PBF (JF), WSPA

<u>Response</u>: The cost estimates in the Staff Report are based on cost calculation methodologies commonly used by the US Environmental Protection Agency when evaluating promulgation of federal regulations, and include a number of adjustments to provide a reasonably conservative estimate of costs. These include adjustments to account for inflation and regional market differences. For example, the Chemical Engineering Plant Cost Index used in the Air District's development of cost estimates is a valid tool for cost estimation, and has been used extensively by the US EPA for cost escalation purposes, and was specifically discussed with refinery participants in the 2019 Refinery Rules Technical Working Group. For this proposal, the Air District used relevant cost data from a recent wet gas scrubber installation in the San Francisco Bay Area. The Air District also used other site-specific information provided by refineries where sufficient supporting evidence was provided. However, some specific cost estimates provided by refineries were asserted without documentation or factual support and thus could not be objectively evaluated.

To further compare and evaluate cost estimates, the Air District also reviewed available information on reported costs of wet gas scrubber installations from other refineries throughout the US. Adjustments to these costs for inflation and regional market differences demonstrated that the cost estimates for the affected refineries were comparable and within the range of costs reported for the other wet gas scrubber installations. These costs for other wet gas scrubber installations are shown in Figure 2 and Table 5 in the Staff Report; as shown in the Staff Report, costs for comparatively sized wet gas scrubber installations on refinery units (adjusted to year 2019 dollars and California market costs) include $210 million for the CITGO Lemont FCCU, $36 million for the Shell Deer Park FCCU, $316 million for the Valero Delaware City Refinery Coker, $579 million for the Valero Benicia FCCU and Coker, and $316 million for the Valero Delaware City Refinery FCCU. While these costs range widely and there are many potential factors that can impact capital costs of these systems, the cost estimates for the proposed amendments of $235 million to $255 are comparable and within the range of costs for these other wet gas scrubber installations.

The Air District also disagrees with the assertion that cost information and estimates provided by industry stakeholders have been ignored. Many of these data sources, factors, and adjustments used in the analysis were discussed with the affected refineries in meetings of the Refinery Rules Technical Working Group in 2019, and staff solicited early input on other information and sources of data for consideration at those meetings as well. Staff also continued to solicit and discuss input from industry stakeholders through various site visits and meetings with individual refineries throughout the rule development process. As described, the Air District has also considered and reviewed the cost information provided by refineries and incorporated site-specific cost considerations in the analysis where sufficient supporting evidence was provided. However, much of the cost information provided by the affected stakeholders did not include sufficient details or supporting information on the cost estimation methodology, assumptions, or data sources. For example, Chevron Products Richmond asserted in December 2020 comments that a wet gas scrubber installation would cost $1.48 billion, but did not provide supporting documentation or further detail on this figure or the development of the cost estimates. Capital cost estimates provided by affected refineries are noted in the Staff Report even where those estimates are not documented. As discussed in the Staff Report, cost estimates provided by Chevron Products Richmond and PBF Martinez Refinery are also substantially higher than any of the wet gas scrubber installation costs reported by other refineries reviewed by staff.

As described above and in the Staff Report, cost data from the wet gas scrubber installation at the Valero Benicia Refinery was considered and incorporated into the development of the cost estimates. The Valero Benicia Refinery wet gas scrubber is a regenerative system, which typically requires additional equipment and higher capital costs. In addition, the Valero Benicia Refinery wet gas scrubber is operated to abate exhaust gas streams from both the refinery's FCCU and coker unit, requiring a larger treatment capacity than what would be anticipated at PBF Martinez Refinery's FCCU. These factors were accounted for in the analysis, and are reflected in the cost estimates.

To provide further context for cost estimates, the Air District reviewed available cost information reported for refinery wet gas scrubber installations at other facilities throughout the US. This cost information in the Staff Report was based on reported and publicly available cost information of previous wet gas scrubber installations at petroleum refineries. Many other potential factors can impact capital costs of these systems, including but not limited to specific design and configuration of the source being abated, wet gas scrubbing system design, additional equipment and equipment modifications required. Performance of any abatement device is dependent on the design and operation of each specific unit. Optimal performance of control systems can depend on many factors, such as equipment type and design, adequate size/capacity, and proper operation and maintenance. Although specific wet gas scrubbing systems may not necessarily be designed or operated to meet the limits included in these proposed amendments, these reported costs still provide relevant information on the types of costs that have been historically incurred for wet gas scrubbing installation and are useful for comparative purposes in the cost estimate analysis. This information has been provided notwithstanding the uncertainties and limitations inherent in using publicly available reported data. Air District staff discussed sources of cost data and emissions performance data with the affected refineries in meetings of the Refinery Rules Technical Working Group in 2019, and solicited input from those stakeholders on other sources of information. Staff did not receive information from the affected refineries on other costs from wet gas scrubbing installations, including any installations at other refineries owned by those companies.

Certain wet gas scrubber designs and technologies, including regenerative system designs, may increase costs due to additional equipment requirements and project complexity. Information about the potential costs associated with the installation of a regenerative wet gas scrubber is included in the Staff Report even though facilities subject to the proposed amendments may choose not to use this technology.

The assumption of increased costs from health mandates related to the COVID-19 pandemic is speculative and not substantiated when considering the compliance deadline and implementation timeframe of the proposed amendments. Given the implementation timeline, most economic forecasts project that the US economy will have substantially recovered from the COVID-related economic downturn early in this time frame. For example, in February 2021, the Congressional Budget Office projected that real GDP will recover to pre-pandemic levels by mid-2021, and that employment levels will recover in 2024 (CBO, 2021).

Congressional Budget Office (CBO). 2021. An Overview of the Economic Outlook: 2021 to 2031. https://www.cbo.gov/publication/56965. February 1.

Compliance costs are overestimated

Comment: Several commenters stated that cost estimates developed for the proposed amendments are too high. One commenter stated that the cost of installation at the Valero Benicia Refinery is not a representative data point. One commenter also stated that the costs provided by industry are not substantiated and should not be included in the report, and that the estimates of costs for water re-use are not substantiated.

350 Bay Area, CBE, S. Rosenblum

Response: While there are multiple potential sources of data and methodologies that may be employed when developing cost estimates, the Air District has followed a robust process to develop and assess the cost estimates included in the analysis. Cost estimates in the Staff Report are based on standardized methodologies, include adjustments to account for inflation and regional market differences, incorporate relevant cost information from a recent Bay Area wet gas scrubber installation, and were evaluated against available reported cost data from other installations throughout the US.

Cost data from the installation of the wet gas scrubber at the Valero Benicia Refinery is a relevant data point for consideration. As described in the Staff Report, the unit at Valero Benicia Refinery is the most recent installation of a wet gas scrubber on a fluidized catalytic cracking unit in California, and the only such refinery wet gas scrubber in the San Francisco Bay Area. Valero's wet gas scrubber design differs from those anticipated at the refineries potentially affected by the proposed amendments primarily in that it is a regenerative system and is used to abate both the FCCU and fluid coking unit at the facility. These differences are accounted for in the Air District's evaluation of costs.

Cost estimates provided by the affected refineries are noted in the Staff Report but were incorporated into the Air District's cost estimates only insofar as they were substantiated. As noted above, cost estimates for wet gas scrubber installation provided by Chevron Products Richmond and PBF Martinez Refinery lacked sufficient supporting documentation and are substantially higher than those for other refineries reviewed by staff.

Wet gas scrubber designs and technologies that re-use water or reduce water consumption typically increase the amount of equipment and complexity involved. The Staff Report includes information for these design and technology options based on industry literature from system vendor/designers. However, it appears unlikely that facilities would use these costlier design options.

Amortization of costs uses incorrect assumptions

Comment: One commenter questioned the basis of assumptions used in the amortization of costs and calculation of annual costs. The commenter suggested a longer depreciation schedule and lower interest rates should be used in the analysis.

J. Kilbreth

Response: As described in the Staff Report, the amortization of capital costs assumes a project lifetime of 20 years at six percent interest. The use of these assumptions is consistent with the approaches and guidelines for the Air District's Policy and Implementation Procedure for Best Available Control Technology (BACT) and US EPA Air Pollution Control Cost Manual. The lifetime of individual installations of wet gas scrubbing systems may vary (and may indeed exceed 20 years in some cases) and different financing mechanisms may be available to the affected facilities (including financing with potentially lower interest rates). However, these assumptions provide a reasonably conservative estimate of the useful life and associated compliance costs from the implementation of these controls. Further, the use of these standardized assumptions provides a consistent framework for analyzing and comparing cost and cost effectiveness values across different control measures and sectors.

Emissions and Modeling

Estimates of emissions and reductions are not accurate

Comment: Commenters stated that refinery emission inventories from 2016-2018 were used in the Air District's health effects analysis, and not recently submitted inventories, which in some cases are significantly lower. One commenter stated that the estimated emission reductions from the proposed amendments are not supported, and previous Air District evaluations show that ammonia reductions had no benefit in reducing secondary PM.

One commenter stated that the PM model includes emissions from the Chevron Refinery's old Hydrogen Plant, a plant that is no longer in operation. The commenter stated that the PM model does not properly account for reductions from the Chevron Richmond Modernization Project, and the Staff Report overestimates refinery-wide PM emissions at Chevron by 294 tons per year, or more than 52 percent.

The commenter stated that the 2018 PM Chevron Refinery-wide emissions inventory figures included in the model are higher than what Chevron reported as part of Regulation 12-15 (Petroleum Refining Emissions Tracking), and it is unclear how the Air District adjusted emissions inventory data and why they are higher than what was reported to BAAQMD for that reporting year.

The commenter stated that the 2018 emissions for Chevron's FCCU in the Staff Report are based on testing results from 2016-2017, which are not an appropriate baseline. The commenter stated that the Air District conducted testing in March 2021, and Chevron has not received the results of that testing. The commenter stated that Chevron conducted parallel source testing, which shows PM emissions at the Chevron Refinery FCCU have been reduced by 106 tons/year or 43 percent of the reported 2018 emission inventory.

One commenter stated that for the PBF Martinez Refinery, staff are using FCCU emission data that is ten years old, rather than data from a more current source test conducted by the facility. The commenter stated that this ten-year-old data was compiled using a source testing method that is no longer EPA approved.

Chevron, PBF (HD), PBF (JL), PBF (ML), PBF (SN), WSPA

Response: Many comments question the data and methodologies used in the modeling of health impacts presented in the Staff Report. As an overarching response, it is important to note that the amendments to Rule 6-5 are proposed under the Air District authority to require Best Available Retrofit Control Technology (BARCT). There is no requirement for modeling of health impacts in connection with adoption of a BARCT rule. The Air District undertook this modeling exercise to provide context for the Board of Directors and the public to consider. However, the sufficiency of the modeling and, for that matter, whether modeling was done at all, is not prerequisite to adoption of the proposed amendments to Rule 6-5.

That legal background noted, the Air District acknowledges that the context provided by the modeling may affect the Board of Directors' consideration of whether to adopt the proposed amendments. The Air District goal of transparency regarding the modeling is independent of whether the modeling is legally required to support adoption of a BARCT rule. As explained the responses that follow, the Air District believes the modeling was done appropriately and that the supporting data is valid.

As described in the Staff Report and the Appendices, the baseline emissions used for the modeling include contributions representative of 2018, the most recent year that emissions have been checked and finalized by the Air District. The Air District also included emission adjustments to reflect significant reductions in non-FCCU sources at Chevron Products Richmond that have occurred since 2018 (due to the Chevron Refinery Modernization Project) and that have been evaluated by the Air District. As described in the Staff Report, estimates of potential emission reductions are based on FCCU emissions and existing performance at the Bay

Area petroleum refineries, and the reductions necessary for compliance with the proposed limits. Ammonia slip can contribute to the formation of condensable particulate matter, which is a type of primary particulate matter; this is different than the secondary particulate matter described in the evaluations referenced by the commenter.

As described in the Staff Report and described in Appendix A.4, baseline emissions used for modeling PM2.5 from the Chevron refinery include contributions representative of 2018, the most recent year that emissions have been checked and finalized by the Air District. However, adjustments were made to reflect reductions in non-FCCU sources that have occurred since 2018, due to Chevron's Modernization Project. Notably, emissions from old hydrogen plant furnaces were omitted from the modeling and replaced with emissions from the new hydrogen plant, where appropriate, to reflect more current conditions. Facility-total adjusted annual PM2.5 baseline emissions match more recent draft emissions (2019) that include Modernization Project changes to within approximately five tons.

As discussed in the Staff Report, the Air District relied upon the Air District's official emissions inventories, which are used for renewing Chevron's Permits to Operate and used for required reporting to the California Air Resources Board. The Air District used the most current emissions inventory for these facilities in its regulatory analysis and modeling. These emissions inventory calculations have been reviewed and approved by Air District technical experts. Information submitted by the refineries, including emissions information submitted per Rule 12-15, are reviewed by Air District staff. Emissions information that are not appropriate for use in the Air District's official emissions inventories, such as data that is not accurate or representative, may not be approved for inclusion in the emission inventories.

The reductions of 43 percent referenced by the commenter are based on emissions estimates that Chevron has made for 2020 that have not yet been evaluated by the Air District for accuracy or representativeness. Testing results at Chevron conducted in March of 2021 are still being evaluated, and it is unclear if these results are representative of typical operations at Chevron.

The estimation of emissions from any facility is by its nature an evolving topic. Emissions estimates are a function of facility operations and measurement methodologies, both of which can and typically do change over time. For purposes of understanding emissions as they relate to adoption of an Air District rule, the only reasonable approach is to use the best available information at the time the rule is proposed. As stated in the Staff Report, the best available information on representative emission levels was used for the PM modeling. For the PBF Martinez Refinery FCCU, additional testing was conducted in 2020 at a variety of different operating conditions. Preliminary review of the 2020 source test data does not indicate emissions lower than previous emissions estimates, and in fact suggest the revised estimate, when it is finalized, may be higher. Air District staff continue to work with PBF to ensure that new emissions estimates are accurate. However, the important point for purposes of the proposed amendments to Rule 6-5 is that preliminary review of the most recent tests do not suggest emissions have been overestimated.

Emissions from other refinery sources and other refineries should not be included in modeling

Comment: Commenters stated that the health effects outlined in the March 2021 Staff Report used the entirety of refinery PM emission sources, however, the proposed amendments to Rule 6-5 are intended to further control PM emissions from refinery FCCUs, which represent a fraction of total refinery PM emissions. Commenters stated that this misrepresentation of data serves to falsely elevate emission reduction estimates, which also artificially inflates the alleged benefits associated with the Rule 6-5 proposed amendments.

Commenters stated that facility-wide PM2.5 modeling inappropriately expanded the Study Area, which results in overestimates of potential impacts in any further modeling using this Study Area. Commenters state that due to the larger Study Area, more receptors (grid cells) were modeled, resulting in higher overall estimated health risks. Commenters stated that since the proposed amendments are focused on the FCCU, only the area where the model predicted PM2.5 annual concentrations greater than 0.1 $\mu g/m^3$ from the FCCU emissions should be included in the BenMAP analysis. One commenter stated that the Study Area used as the input to BenMAP included receptors where the PM2.5 concentrations were less than 0.1 $\mu g/m^3$.

Commenters stated that emissions from the Marathon Martinez Refinery should not be included in the Staff Report or in the modeling of PM health impacts. Commenters state that including the Marathon emissions in the analysis when it is clear those emissions are no longer occurring, and may never occur again, undercuts the District's analysis and renders the proposed rule unsupported by any substantial evidence.

Chevron, WSPA

Response: As noted above, modeling for health impacts is not required for, nor is it a normal part of, the analysis of BARCT. The Air District conducted modeling to provide context for the BARCT determination in the proposed amendments, but the modeling is not part of the BARCT determination. The BARCT analysis does not in any way hinge on the modeling presented in the Staff Report. Air District staff made judgements regarding how to use modeling to provide context, but acknowledge that there is not one correct or even best way to establish context.

The chosen study area was intended to focus on impacts and benefits for the communities in the Bay Area refinery corridor. PM2.5 concentrations and health impacts do not end outside the study area. The Air District's analysis focused on the areas near the refineries, and therefore understates the health benefits of the proposed rule to the broader Bay Area. Choosing the entire Bay Area region would have been another way to establish context. Compared to what has been presented, preliminary work by the Air District indicates that assessing the entire region would approximately double the total modeled exposure and estimated benefits. Section V.E.3 of the Staff Report acknowledges that the size of the study area, as defined and used in the Staff Report, was indirectly linked to baseline emission estimates.

The calculation of health benefits is based on the difference between the baseline case and the control case. This difference is only dependent on FCCU emissions, as all other sources are held constant across all scenarios. Therefore, the emission inventory for any modeled sources other than FCCUs has no bearing on the reported valuations of health benefits, and the accuracy of non-FCCU emission estimates is immaterial as far as the health benefits assessment is concerned.

As noted in the Staff Report, the Marathon Martinez Refinery announced the idling of the refinery, including the facility's fluidized catalytic cracking unit, in April 2020. Marathon announced in July 2020 that the facility would remain indefinitely idled with no plans to restart. Although the Marathon Martinez Refinery FCCU is not currently operating and no plans have been announced to restart those operations, the FCCU is still a permitted source with a permit to operate. As such, the FCCU at the Marathon Martinez Refinery would be a potentially affected source under the proposed amendments. Therefore, the Air District has included information on the Marathon Martinez Refinery FCCU emissions and potential compliance costs in the analysis. Modeling of health impacts and potential health benefits of PM reductions and controls did not include emissions from the Marathon Martinez Refinery.

Modeling inputs should be further explained and more transparent

Comment: One commenter stated that more description of the care taken in preparing and conducting the air quality modeling should be provided.

One commenter stated that the full suite of modeling files has not been provided, so a complete analysis of the District's modeling, and the results obtained, could not be performed.

Chevron, Montrose AQS

Response: The modeling reports (Appendixes A.2 and A.4) provide extensive description of the care taken in preparing and conducting the air quality modeling, including discussions throughout the documents about quality assurance and quality control. In particular, pages 13 through 17 include the discussion of the preparation of modeling inputs for emissions control scenario B. A lengthy discussion on the preparation of stack parameters for control scenario B is also provided.

As noted above, the modeling presented in the Staff Report is intended to provide context for the BARCT determination, but is not part of the BARCT determination. The Air District has attempted to be thorough in its explanation of the modeling. However, to the extent commenters are suggesting that the validity of the proposed amendments depends on whether affected facilities or members of the public are able to exactly replicate the modeling, the Air District disagrees. The Board of Directors may consider the context provided by the modeling presented by Air District staff, but it may also consider other perspectives on context presented by affected facilities or the public.

The Air District has cooperated with efforts by affected facilities to understand and critique the modeling in the Staff Report. Air District staff have provided modeling data requested through Public Record Requests, and have attempted to answer questions from affected facilities regarding the modeling.

Air quality model selection is not appropriate

Comment: One commenter stated that the CALPUFF model version used in the Air District's modeling was neither the EPA approved version nor the latest version of CALPUFF. The commenter stated that the Air District did not use photochemical grid models like CAMx and CMAQ, which are designed to model chemical transformation of emissions (as in secondary PM2.5). The commenter stated that the BenMAP study area extended as far as 65 kilometers from the FCCU, into the long-range transport assessment range, and long-range transport of pollutants is the specific type of assessment for which EPA delisted the use of CALPUFF. The commenter stated that use of CALPUFF modeling results at this range for a regulatory application is inappropriate.

One commenter stated that the environmental consultant ERM performed PM2.5 dispersion modeling in the AERMOD model using the same modeling inputs (source emissions and stack parameters) and surface data from Chevron's onsite meteorological station, with upper air and supplemental surface data from Oakland International Airport obtained from the Air District. The commenter states that the results show that modeled ground-level concentrations resulting from FCCU emissions occur over the Bay, avoiding populated areas near the refinery, and the magnitude of these maximum concentrations are significantly less than the District's reported maximum concentration. The commenter stated that the Air District should use AERMOD for their FCCU PM dispersion modeling.

Chevron

Response: CALPUFF version 6.4.2 was used. This is a version of CALPUFF later than the EPA approved version (5.8.5). This later version of the model has been applied by the Air District for various projects including an SO2 demonstration project that was submitted to EPA and the findings of which EPA has approved. The US EPA has not "delisted the use of CALPUFF." Revised guidelines "no longer contain language that requires the use of CALPUFF." (82 FR 5195)

The Air District applied models to track directly emitted PM and did not include PM generated from chemical transformation of gases emitted since the proposed regulation is for control of directly emitted PM. Photochemical models, such as CAMx and CMAQ, were not used because chemical transformation of gases to PM was not simulated, i.e., no chemical transformation is included in the simulated PM.

Insufficient information is provided from the ERM modeling with the AERMOD model to make a full assessment, but the results presented are inconsistent with wind patterns in the region. (1) Data from Oakland sounding below 300 meters (height of east Bay hills) are significantly modified by local terrain. As a result, they would not represent conditions in Richmond. In other words, it is inappropriate to use Oakland sounding data for Richmond in applying the AERMOD model. (2) Richmond onsite meteorological data is strongly influenced by topography. Even though predominant winds at onsite meteorological site are from the south, they turn toward east starting from just a few kilometers of downwind areas of Chevron. The AERMOD model is unable capture the impacts of turning winds because it utilizes winds from a single meteorological station. As a result, the use of AERMOD is a less appropriate model for assessing

PM emissions from Chevron for the purpose of exposure and health impacts analyses, because these emissions are typically from tall, hot, stacks that disperse the pollution over a broad area.

Refineries are large sources of PM emissions. Bay Area refineries are located in areas with complex winds that can change direction over distances of a few kilometers. Plumes of PM can extend far from the stack release points. The Air District's modeling of PM was for assessments of refinery emissions on human health and exposure in an extended area to track the emission plumes around the Bay Delta. A Lagrangian "puff" model, such as the CALPUFF model the Air District applied, is an appropriate model for this type of assessment. The AERMOD model will not accurately track the motion of the refinery plumes in this complex wind environment and is a less appropriate model for this type of source and assessment. As noted in the Federal Register (82 FR 5196), "[t]he EPA recognizes that AERMOD, as a Gaussian plume dispersion model, may be limited in its ability to appropriately address such situations, and that CALPUFF or other Lagrangian model may be more suitable…"

Federal Register, Vol. 82, Page 5195. (82 FR 5195) January 17, 2017.
Federal Register, Vol. 82, Page 5196. (82 FR 5196) January 17, 2017.

Modeling parameters are not appropriate

Comment: One commenter stated that the Air District ran CALPUFF with certain parameters that are known to affect dispersion of emitted pollutants and impact modeled ground-level concentrations. The commenter stated that building downwash was not modeled, urban dispersion parameters were only used for model cells that were in the "industrial land use" category, and the Air District failed to use an algorithm that, if enabled, would have better characterized the shoreline thermal effects (the difference in temperature between water and land) in the Bay Area.

The commenter stated that the modeling failed to accurately model the configuration of numerous sources. The commenter stated that the base elevations for each source, even if adjusted to use grid average terrain, are inaccurate. The commenter stated that elevations should be representative of the 100-meter modeling grid, and many source elevations are significantly different than any elevation within 100 meters from that source, which will significantly impact the distance and direction of modeled emissions due to variation in wind speed and direction with height.

Chevron

Response: Modeling of building downwash is not necessary because: (1) there are no tall buildings adjacent to the stacks; and (2) building downwash would only impact concentrations inside of the facility fence line.

In the CALPUFF model, urban dispersion parameters are designed for the core urban areas, such as downtown Richmond. The model parameters were selected properly for the region modeled.

The algorithm referenced in the comment is for improved handling of plume diffusion and dispersion over waters when the plume moves from over land to over water. This algorithm was not used for several reasons: (1) It is most useful with meteorological data prepared by the CALMET processor, which is designed to characterize vertical mixing processes, including estimating boundary layer heights over water and over land separately when there is a strong temperature gradient between the two areas. However, the District used the Weather Research and Forecasting (WRF) model, which includes more realistic formulations for vertical mixing than CALMET regardless of whether the area is over water or land. (2) There is no strong ambient temperature gradient between the location of refinery emissions over land and downwind locations that are over water (based on WRF simulated temperature data). (3) Boundary layer processes in the region are dominated by mechanical mixing due to the sea breeze. The effect of buoyancy is minimal.

The computational grid resolution of CALPUFF was 1x1 kilometer. Meteorology, terrain elevation, land use, etc., were provided to the model at this resolution and the base elevation was adjusted accordingly. The receptor domain was set at 100-meter spacing. The model is designed to operate with terrain elevations specified at the computational grid resolution, not at the receptor resolution. The suggested model specification would be inconsistent with model operation and the model would not function properly with the suggested specifications.

Emission and pollutant parameters used for modeling are not appropriate

Comment: One commenter stated that measurements of PM2.5 using a direct-reading device or a laboratory method are always subject to some measurement errors, and the report should provide the measurement uncertainty of the PM2.5 emission measurements and model the ranges.

One commenter stated that the report does not mention input into the CALPUFF model, such as particle aerodynamic diameter size distribution and density, or any FCCU particulate analysis. The commenter stated that the report should include a comparison of the PM2.5 data entered in the model and the actual PM2.5 in the FCCU. One commenter stated that the report states that PM2.5 is a complex mixture of suspended particles and liquid droplets, but FCCU particulate is not liquid, and the report does not include information on its aerodynamic diameters that relates to its staying suspended in ambient air.

One commenter stated that Section 2.2 of the modeling report states the use of average emissions, and questioned if the underlying value distribution was lognormal. The commenter stated that arithmetic averages of lognormal data can grossly over-estimate the average.

PBF (PO)

Response: Standard procedures for estimating facility emissions do not provide uncertainty estimates. While uncertainty estimates may be of theoretical interest, neither regulated facilities nor regulatory agencies typically produce them. As described in the Staff Report and Appendices, the Air District used the best available emissions estimates to conduct the modeling assessments.

Emissions inputs for CALPUFF represent total PM2.5 and were not distributed into different size bins. Resulting concentration values output by CALPUFF also represent total PM2.5, and these concentrations were used as input to the US EPA's Benefits Mapping and Analysis Program, Community Edition (BenMAP-CE or BenMAP). CALPUFF does use an internal PM2.5 size distribution for the purpose of calculating dry deposition velocity, and the District used the default CALPUFF distribution for this purpose. The purpose of the statement "PM2.5 is a complex mixture of suspended particles and liquid droplets" in the introduction section of the modeling report was to describe PM2.5 in a general sense. It was not intended as a description of FCCU emissions or emissions from a specific source.

Section 2.2 of the modeling report (Appendix A.4) deals with meteorological modeling, and no reference to "average emissions" occurs in the emissions inventory section (Section 2.1). Emissions used as model inputs were intended to be representative of "routine operations" for the facility over the span of a year. Omitted from "routine operations" were emissions from upsets, accidental releases, startups, and shutdowns. If emission estimates did include upsets, accidental releases, startups, and shutdowns—events for which emissions can be higher—this could result in a lognormal distribution, a distribution with infrequent periods of much higher levels. However, during conditions of routine operation, arithmetic averaging is appropriate.

PBF (PO)

Meteorological data used in the modeling are not appropriate

Comment: Commenters stated that meteorological data used in the modeling contained inaccuracies and is not appropriate. Commenters stated that the Air District's modeling did not use local meteorological data, and therefore, doesn't effectively track the dissipation or regional movement of PM. One commenter stated that it was not clear whether the Air District used the Chevron Refinery's onsite meteorological data to blend onsite observations with the other meteorological stations in the Weather Research and Forecasting (WRF) model. The commenter stated that doing so would help to simulate the local wind conditions more accurately in the subsequent dispersion modeling.

One commenter stated that insufficient information was provided to assess how the meteorological data were developed in CALMET, a companion processing program to CALPUFF. The commenter stated that the Air District's evaluation of the meteorological data was performed using a program called METSTAT, which is an outdated tool that has been superseded by a program called AMET. The commenter stated that AMET was developed by USEPA and is a more comprehensive tool than METSTAT.

The commenter stated that wind speed was underestimated in CALMET compared to the onsite meteorological station, which will tend to overestimate modeled ground-level concentrations and bias the CALPUFF results to significant overprediction. The commenter stated that the CALMET wind direction data showed a bias in the clockwise direction compared to observations at the onsite meteorological tower, which would tend to incorrectly bias modeled ground-level concentrations by directing the plume more towards populated areas instead of over the Bay.

The commenter stated that vertical profile data from the Air District Sodar station on the Chevron property should also have been included in CALMET and would provide a significantly better vertical atmospheric profile near the FCCU. The commenter stated that the vertical atmospheric profile will determine to what extent emitted pollutants disperse in the atmosphere or reach ground-level, and its accuracy is extremely important to achieving accurate modeled concentrations.

Chevron, WSPA

Response: Meteorological modeling results were used as meteorological inputs to the air quality model, and these results were determined to be representative of the region by comparison to meteorological monitoring data. On-site meteorological data were not used in the four-dimensional data assimilation of the Weather Research and Forecasting (WRF) model because the assimilation module requires pressure measurements in addition to winds, temperatures, and humidity. Pressure is not measured at the Chevron on-site meteorological station.

Both METSTAT and AMET use the same set of statistical measures for model evaluation, such as bias, error, etc. There is no advantage of using one software over the other.

The simulated windspeed represents an average speed across a 1x1 kilometer grid cell. Observations represent a speed at a single location. It is reasonable that there can be differences in grid cell wind speeds and single point observations. This does not signify overestimation by CALPUFF.

Care must be taken when a single point measurement is compared against a grid-average estimate. The predominant airflow of the region starts from the Pacific Ocean, enters the Bay through the Golden Gate gap, branches near Oakland, with the southerly branch continuing through Richmond and turning toward the east along the Delta. The model captures this overall airflow structure very well.

Data from the onsite SODAR station were compared against nearby measurements such as measurements at Richmond and Point San Pablo meteorological towers. SODAR data were often inconsistent with other nearby measurements and the Air District has been investigating whether this SODAR instrument is functioning properly. As a result, these data were not used for modeling.

Modeling results should be presented differently

Comment: One commenter stated that the staff should provide additional modeling results/figures of the contributions after each of the two control levels to provide a clearer depiction of the improvements to air quality expected.

One commenter stated that Appendix A.4, Figure 3.2.1, for the FCCU without WGS shows that CALPUFF predicted maximum modeled PM2.5 ground-level concentrations of 0.1 - 0.2 µg/m3 in a small area where people live, and 0.2 - 0.3 µg/m3 in a very small area where people might work. The commenter stated that these concentrations are significantly lower than the concentrations presented in Appendix A.4, Table 3.2.1, and this table is misleading as the peak offsite concentration it reports is predicted to occur next to the refinery in San Francisco Bay, at a location where no residential or worker receptors are located, as shown in Figure 1(a).

One commenter stated that the report states the PM2.5 emissions result in 2.8 to 6.3 premature deaths per year, and questioned what a '0.8' or '0.3' premature death was.

One commenter stated that the Air District mislabeled its dispersion modeling results as "exposures", whereas the District's analysis appears to have been an analysis of impacts on outdoor air concentrations rather than people's exposures. The commenter states that air pollution-related health effects are a function of exposures, and when people are indoors at their residences, it has been estimated that the exposures are 30-40 percent lower than the outdoor concentrations due to deposition and filtration.

One commenter questioned how the approximate 1 percent average decrease in outdoor PM2.5 concentrations is being associated with the greater than 20 percent differences in health outcomes as identified in Table 11.

Chevron, Montrose AQS, PBF (PO), WSPA

Response: The bar charts provided in the Staff Report and Appendix A graphically depict the modeled improvements expected after implementation of each of the two control scenarios.

Simulated ambient PM levels were analyzed in Appendix A.4. Figure 3.2.1 of that appendix shows a map of simulated PM from FCCU emissions. Table 3.2.1 shows a comparison of emissions, maximum simulated concentrations, and number of receptors with concentrations above 0.1 µg/m3 for emissions from all facility sources, FCCU only, and FCCU with assumed wet gas scrubber (WGS) control. Appendix A.4 provides ambient analysis of PM regardless of population. Population exposure to PM from these sources provided in Appendix A.2.

The Staff Report does not refer to fractional deaths, which have no meaning. However, the Staff Report does reference fractional death rates, which do have meaning. An annualized rate of 2.8 death per year corresponds to 28 deaths over a 10-year timespan. Similarly, a rate of 6.3 death per year corresponds to 63 deaths over a 10-year timespan.

Outdoor ambient concentrations correspond to the dependent variable in the response functions that the Air District is relying on. It would be inappropriate to adjust these (e.g., by multiplying by an indoor/outdoor ratio), because such adjustments were not performed in the corresponding studies. Referring to that dependent variable as "exposure", when it is weighted by population, is common and consistent with established practice.

Regarding the results presented in Table 11, the reported percent reductions in health impacts correspond to the PM from modeled sources, not PM from all sources.

Modeling results should be compared and calibrated to monitoring data

Comment: Commenters stated that air dispersion modeling of PM contributions and health impacts from FCCUs have not been calibrated to monitoring measurements of PM in the surrounding communities. Commenters stated that staff should provide an analysis for Air

District monitoring stations PM2.5 data over many years while noting the weeks when the PBF Martinez Refinery FCCU was shut down for maintenance and not emitting PM.

One commenter stated that ambient air monitoring in the vicinity of the Chevron Refinery does not support BAAQMD's modeled PM2.5 impacts from the FCCU or the Refinery as a whole. The commenter stated Chevron Refinery is generally west-southwest of BAAQMD's San Pablo Rumrill Station, and one would expect the measured PM2.5 when winds are from this sector to be elevated, if the refinery actually was causing local elevated PM2.5. The commenter stated that ambient data does not show a statistically significant difference in ambient PM2.5 concentrations during a two-and-a-half-month period in which the Chevron Refinery FCCU was shut down and not operational.

Chevron, PBF (BN1), PBF (PO)

Response: Air monitoring stations measure PM from all sources, including secondary PM formation and PM that has been transported from other areas. No ambient PM monitoring is available for emissions from a specific source such as the FCCU. Therefore, the proposed calibration is not feasible.

Variations in measured hourly or daily ambient PM concentrations are difficult to assign to the contributions from a specific, individual source, and are also affected by meteorological conditions, and day-to-day changes in the emissions of PM or PM precursors from other local and regional sources.

Air monitoring stations measure ambient PM from all sources as well as the contribution of background concentrations. As a result, simulated PM from refinery emissions (entire refinery or FCCU) is not comparable to ambient levels of PM monitored at air monitoring stations. The suggested comparison and conclusion are not useful assessments.

The actual PM emissions from the FCCU were simulated for three years and resulting PM contributions to concentrations were documented. While some reduction in ambient total PM concentrations from the temporary shutdown of the FCCU occurred, and while the modeling predicts an estimated average magnitude of FCCU emissions changes, the measured ambient total PM levels also reflect differences in meteorological conditions between the two periods, as well as variability in other sources of primary and secondary PM.

Affected sources represent only a small portion of all Bay Area emissions and reductions would not result in appreciable benefits

Comment: Commenters stated that estimated PM10 emissions from FCCUs are a small portion of all Bay Area PM10 emissions, and reductions under the proposal represent less than one percent of total Bay Area PM10 emissions.

One commenter stated that there is no supporting evidence that FCCU emissions make up three percent of PM emission in the Bay Area.

Chevron, EBLC, PBF (BN1), PBF (HD), PBF (JS), PBF (ML)

Response: The Air District recognizes that there are many sources of emissions throughout the Bay Area, however, FCCUs are among the largest individual sources of PM emissions in the San Francisco Bay Area. Table 1 in the Staff Report reports total PM10 emissions from petroleum FCCUs to be approximately 825 tons per year. Total human-generated criteria pollutant emissions for all California air districts are publicly available online through the California Air Resource Board's CEPAMv1.05 emissions reporting tool (https://ww2.arb.ca.gov/criteria-pollutant-emission-inventory-data). For the Bay Area Air District, human-generated PM10 emissions total about 32,000 tons per year; therefore, the FCCU contribution of 825 tons per year represents approximately 3 percent.

The Bay Area is already under the National Ambient Air Quality Standard for PM

Comment: Commenters stated that the Bay Area is already under the National Ambient Air Quality Standard (NAAQS) for PM.

PBF (BN1), PBF (JF)

Response: The San Francisco Bay Area Air Basin is currently designated nonattainment for the National Ambient Air Quality Standard (NAAQS) for 24-hour PM2.5 and for the California Ambient Air Quality Standards (CAAQS) for annual PM2.5, annual PM10, and 24-hour PM10.

While progress has been made and monitoring data in some previous years have been below the NAAQS, the 2018-2020 design value (which is the air monitoring data indicator used for comparison with the ambient air quality standard attainment) is 55 $\mu g/m^3$ for 24-hour PM2.5 and 11.3 $\mu g/m^3$ for annual PM2.5. Achieving and maintaining attainment of all the PM2.5 NAAQS and CAAQS remains a challenge that necessitates further reductions of particulate matter emissions and their precursors.

Environmental Impacts

CEQA requirements have not been fulfilled

Comment: Commenters stated the Air District has not conducted an adequate CEQA analysis for the Proposed Amendments. Commenters state that the Air District is relying on an inappropriate CEQA EIR and needs to prepare an EIR for this rule development. Commenters state that the Air District relies on Public Resources Code Section 21166, which sets forth the standard for the need to conduct additional environmental review in connection with a previously approved project, and that this is not the appropriate inquiry under the circumstances because the Proposed Amendments are not the same project that was evaluated in the EIR. Commenters state that there is significant new information that requires that the District conduct additional environmental review and prepare a subsequent or supplemental EIR. Commenters stated the EIR does not contemplate the potential environmental consequences if the proposed regulation limits cannot be met, in which case the operations may have to cease to operate, which would lead to environmental impacts.

Commenters stated that although the EIR discussed at a general level the possibility of using wet gas scrubbers for refinery FCCUs, it did not contain any detailed discussion or evaluation of environmental impacts from amendments to Rule 6-5. Commenters stated that none of the requirements in the proposed amendments were discussed in detail in the EIR, and the impacts of these specific amendments were not addressed in the EIR. Commenters stated that at the time of the 2018 EIR, it was unclear what exactly the proposed amendments for Rule 6-5 would entail, and significant new, material information now exists as to the potential environmental impacts of the proposed amendments.

Chevron, PBF (JF), WSPA

Response: The primary purpose of the 2018 EIR was to evaluate the proposed schedule for adoption of BARCT rules expected to be needed to implement AB 617. With regard to control of PM from FCCUs at refineries, the 2018 EIR went further than evaluation of the schedule and included a thorough evaluation of impacts from the two most likely control options. It is therefore not the case that, as one commenter asserted, wet gas scrubbers were discussed only at a "general level." Because it was known at the time of the 2018 EIR that electrostatic precipitators and wet gas scrubbers were the primary options for further control of particulate from FCCUs, these control options are evaluated in great detail and side-by-side throughout the EIR.

The 2018 EIR was occasioned by a different project than the current proposed amendments to Rule 6-5. However, the Air District believes comments that cite this as the reason why the 2018 EIR cannot be adequate to support the Rule 6-5 amendments elevate form over substance. Revisions to Rule 6-5 to require either electrostatic precipitators or wet gas scrubbers had begun to be considered as early as August 2018, as discussed in the CEQA Initial Study for the AB 617 Expedited BARCT Implementation Schedule. Even though the decision being made in 2018 was whether to proceed with the Expedited BARCT Schedule, the state of understanding regarding future control options for particulate from FCCUs allowed the Air District to fully evaluate the impacts of these options. The result was an EIR in support of the Expedited BARCT Schedule that addressed the full range of choices at issue in the proposed amendments Rule 6-5 amendments, and that is substantively sufficient to evaluate the impacts of those choices as required by CEQA.

The standard practice in the evaluation of environmental impacts under CEQA is to assume compliance with applicable laws and regulations. This is one reason why evaluation of a scenario in which a refinery ceases operation because it cannot comply with the proposed amendments was not addressed in the EIR. Just as importantly, the prediction, first, that a refinery would cease operations and, second, that the cessation would be due to the difficulty in complying with the proposed amendments entails layers of speculation that put the scenario beyond the scope of reasonable likelihood that informs the breadth of CEQA review.

The public and affected facilities have had the opportunity to comment on this analysis in the context of this proposal to amend Rule 6-5. The Air District has reviewed these comments and is responding to each point regarding the adequacy of the 2018 EIR. The 2018 EIR cannot be revised in response to comments – it either is sufficient to support adoption of the proposed Rule 6-5 amendments or it is not. The Air District has explained in response to each specific comment on the 2018 EIR why it believes the CEQA analysis continues to be adequate.

The Final EIR for the AB 617 Expedited BARCT Implementation Schedule has been included with the package for proposed amendments to Rule 6-5 for consideration by the Air District Board of Directors.

The Air District has not properly analyzed alternatives under CEQA

Comment: Commenters stated that the Air District has failed to properly analyze a reasonable range of alternatives under Section 15126.6 of the CEQA Guidelines. Commenters stated that the 2018 EIR regarded the timing of multiple District rules, rather than address the impacts of this proposed action and its alternatives. Commenters stated that the EIR identifies the only alternatives as (1) not implementing the Expedited BARCT Implementation Schedule and (2) delaying implementation. Commenters stated that the EIR does mention that there are different types of wet gas scrubbers with different energy impacts, but does not provide any analysis of the tradeoffs between the greenhouse gas impacts and PM control effectiveness of these options. Commenters stated that the given that the EIR public notice and title referred to timing and only considered timing alternatives, it is not surprising that comments were limited despite the extensive amount of interest in the details of these rules on the part of both the public and the affected industries.

Commenters stated that the District has previously drafted two rule alternatives to Rule 6-5, and 2018 EIR does not identify these alternatives or provide quantitative information that is useful to the public or decisionmakers with regard to weighing those tradeoffs and the significant environmental impacts of Rule 6-5. Commenters state that while the Final EIR does mention that the potential water demand associated with a wet gas scrubber could result in significant impacts, it does not acknowledge the fact that alternatives to the proposed rule would not necessitate a WGS or those associated impacts. Commenters stated that new information of substantial importance exists as to alternatives for the Proposed Amendments, and supplemental or subsequent environmental review is required when new information of substantial importance shows that alternatives which are considerably different from those analyzed in the previous EIR would substantially reduce one or more significant effects on the environment.

Chevron, PBF (JF), WSPA

Response: The primary purpose of the 2018 EIR was to evaluate the proposed schedule for adoption of BARCT rules expected to be needed to implement AB 617. With regard to control of PM from FCCUs at refineries, the 2018 EIR went further than evaluation of the schedule and included a thorough evaluation of impacts from the two most likely control options. Electrostatic precipitators and Wet Gas Scrubbers are evaluated side-by-side throughout the 2018 EIR.

Focusing on water usages as a prominent example, Table 3.4-4 includes a column titled “Uses Water?” In adjacent cells in that table, the question is answered “yes” for wet gas scrubbers and “no” for electrostatic precipitators. Table 3.4-6 describes the worst case water usage scenario of three simultaneously operating wet gas scrubbers as using 1,296,000 gallons per day of water. The reader is thus clearly informed that the potential water savings if electrostatic precipitators are chosen as the control option rather than wet gas scrubbers is 1,296,000 gallons per day. This example is illustrative of how the 2018 EIR examined electrostatic precipitators and wet gas scrubbers side-by-side as alternative control options throughout the document.

The control options under evaluation for Rule 6-5 were not formally evaluated in the "Alternatives" chapter of the 2018 EIR because that choice was not at issue in the Expedited BARCT Schedule. Nevertheless, the comparison of impacts from the two control options was as thorough as possible. Although the two control options were not presented as choices in the alternatives section of the EIR, doing so would not have resulted in additional information regarding the control options individually or in direct comparison to each other. Expressed another way, if the 2018 EIR were revised to feature the electrostatic precipitators and wet gas scrubbers in the "Alternatives" section of the document, there would be no change in either content or in how the two control options are compared to each other because the 2018 EIR was prepared with an explicit understanding that amendments to Rule 6-5 would present exactly this choice.

The Air District believes the 2018 EIR continues to be adequate to inform the Air District Board and the public of the impacts of these control options. Various comments assert specific arguments that relevant information was excluded from that EIR and/or that circumstances have changed such that a new or supplemental EIR is needed. The Air District responds to each of these specific comments in responses that follow below.

The Air District sets emission limits based on what is achievable by available control technologies, but does not have authority to prescribe the exact equipment that must be used to meet those limits. Though a refinery subject to proposed amendments to Rule 6-5 may have a choice of wet gas scrubbers, the Air District cannot dictate how that choice is made as long as the emissions limit is met. It follows that different types of wet gas scrubbers are not alternatives appropriate for evaluation under CEQA. The 2018 EIR assumed the most impactful version of wet gas scrubber with respect to each environmental media so that the most significant impact would be evaluated regardless of which choice of scrubber is ultimately made by a refinery.

The Air District has not complied with CEQA requirements for mitigation of impacts

<u>Comment</u>: Commenters state that the District has failed to comply with CEQA requirements that significant impacts be mitigated or that findings be made that support overriding considerations. Commenters state that reliance upon a 2018 Final EIR that finds water impacts are significant, yet does not provide feasible mitigation, is a violation of CEQA under CEQA Section 15126.4. Commenters state that the District did not analyze whether recycled water was available to the three facilities, or just one site and if so, what would the cumulative impact be of the remaining facilities not using recycled water.

Commenters state that new information of substantial importance exists as to mitigation measures for the proposed amendments. Commenters state that a subsequent or supplemental EIR is required when new information of substantial importance shows that mitigation measures which are considerably different from those analyzed in the previous EIR would substantially reduce one or more significant effects on the environment, but the project proponents decline to adopt the mitigation measure. Commenters state that the EIR does not identify any mitigation measures to address significant water impacts, including mitigations that could include a regenerative wet gas scrubber, which would use less water than non-regenerative wet gas scrubbers.

Chevron, PBF (JF), WSPA

Response: The EIR found that water demand from the use of wet gas scrubbers would result in significant and unavoidable water use impacts. The EIR identifies potential mitigation measures, including HWQ-1, which required to use recirculated, reclaimed, or recycled water, if available, to satisfy the water demand for the air pollution control equipment. This includes the type of regenerative wet gas scrubber designs referenced by the commenter. The EIR concluded that in spite of implementing the mitigation measures, impacts would remain significant and unavoidable. This information was provided to the Air District Board of Directors for consideration during the certification of the EIR and adoption of the AB 617 Expedited BARCT Implementation Schedule in 2018. On December 19, 2018, the Board of Directors adopted a resolution to adopt the AB 617 Expedited BARCT Implementation Schedule, certify the Final EIR, and issue a Statement of Overriding Considerations.

The Air District believes that comments submitted on the proposed amendments have not revealed new information of substantial importance. The specific reasons why are explained in responses to specific comments below.

The Final EIR for the AB 617 Expedited BARCT Implementation Schedule and the December 2018 Statement of Overriding Considerations has been included with the package for proposed amendments to Rule 6-5 for consideration by the Air District Board of Directors.

The Air District has not properly analyzed cumulative impacts under CEQA

Comment: Commenters state that the Air District has failed to properly analyze cumulative effects under CEQA Section 15130. Commenters stated that the District has dramatically underestimated the environmental impacts associated with installing multiple mandated WGSs in the Bay Area. Commenters stated that the District did not properly analyze the water demand without the mitigation coupled with other impacts due to increases in energy use, GHGs and other impacts.

PBF (JF), WSPA

Response: The 2018 EIR contains analysis of cumulative impacts in EIR Chapter 3 as required by CEQA. Included for each impact category is a discussion of whether the proposed project will result in any significant impacts, either individually or cumulatively in conjunction with other projects. As shown in EIR Table 2-4, the environmental review analyzed the installation of up to three wet gas scrubbing units. The EIR discussed impacts to all resource areas, including water demand, energy use, and greenhouse gases in EIR Chapter 3.

The Air District has not fully analyzed and mitigated water impacts under CEQA

Comment: Commenters stated that the District has failed to fully analyze and mitigate the significant environmental impacts of multiple mandated wet gas scrubbers that would be required under the proposed amendments. Commenters stated that the EIR does not include any meaningful discussion regarding all impacts relating to wet gas scrubbers, which are required before the Air District can consider adopting the Proposed Amendments. Commenters stated that wet gas scrubbers would significantly increase freshwater demand in a region already constrained by water supply and in drought conditions.

Commenters stated that the EIR does not identify appropriate feasible mitigation measures, as it does not address whether recycled water would be available to the facilities. Commenters stated that the EIR does not identify further mitigation if such recycled water is not available.

Commenters also stated that the District has failed to fully analyze and mitigate the potentially significant water quality impacts of wet gas scrubbers.

Chevron, EBLC, PBF (DB), PBF (JF), PBF (ML), PBF (RM), PBF Energy, WSPA

Response: An evaluation and discussion of the potential water use impacts of wet gas scrubbing systems was included in the Final Environmental Impact Report (EIR) for the AB 617 Expedited BARCT Implementation Schedule, which was certified by the Air District Board of Directors in 2018. The EIR discussion included estimates of water usage for up to 3 wet gas scrubber installations, and found that water demand from the use of wet gas scrubbers would result in significant water use impacts. The EIR identified potential mitigation measures HWQ-1 and HWQ-2. The EIR specifically noted that there is no guarantee that reclaimed water would be available to all affected facilities. Therefore, the EIR found that in spite of the identified mitigation measures, impacts would remain significant and cumulatively considerable.

Potential impacts from wastewater and water quality were discussed in the EIR Section 3.4. The EIR discussed potential water quality impacts from operation of wet gas scrubbers, and found that water quality impacts were less than significant. In addition, the Response to Comments in the Final EIR further addressed comments on potential wastewater impacts.

This information was provided to the Air District Board of Directors for consideration during the certification of the EIR and adoption of the AB 617 Expedited BARCT Implementation Schedule in 2018. On December 19, 2018, the Board of Directors adopted a resolution to adopt the AB 617 Expedited BARCT Implementation Schedule, certify the Final EIR, and issue a Statement of Overriding Considerations. The Final EIR for the AB 617 Expedited BARCT Implementation Schedule has been included with the package for proposed amendments to Rule 6-5 for consideration by the Air District Board of Directors.

The Air District has not properly analyzed and mitigated GHG impacts under CEQA

Comment: Commenters stated that the Air District has failed to properly analyze Greenhouse Gas Emissions. Commenters state that there is no discussion in the March 2021 Staff Report or the Final EIR (Appendix D) being relied on by the District as to whether the project complies with GHG reduction plans. Commenters stated that while the EIR summarily concludes that because the facilities must comply with the Cap-and-Trade Program, the Expedited BARCT Implementation Schedule would have a less than significant impact on greenhouse gas (GHG) emissions, the District is still obligated to analyze the impact of GHGs, which would increase from higher energy demands of the wet gas scrubber.

Chevron, PBF (DB), PBF (JF), PBF (ML), PBF Energy, WSPA

Response: The 2018 Final EIR and CEQA Initial Study address the potential impacts from greenhouse gas emissions, and specifically compliance with plans for the reduction or mitigation of greenhouse gas emissions.

As discussed in the CEQA Initial Study, CEQA Guidelines section 15064.4, promulgated in 2010, sets out the procedures for determining the significance of a project's greenhouse gas emissions. In making that determination, subdivision (b)(3) of that section allows a lead agency to consider "[t]he extent to which the project complies with regulations or requirements adopted to implement a statewide, regional, or local plan for the reduction or mitigation of greenhouse gas emissions."

In 2011, California Air Resources Board promulgated the regulations establishing the Cap-and-Trade Program (Cal. Code Regs., tit. 17, §§ 95801–96022) to reduce greenhouse gas emissions under the California Global Warming Solutions Act of 2006. The Cap-and-Trade Program seeks to reduce emissions of greenhouse gases from the subject sources by applying an aggregate greenhouse gas allowance budget on covered entities and providing a trading mechanism for greenhouse gas emission allowances or offsets. (Cal. Code Regs., tit. 17, § 95801.) Cap and Trade constitutes a "plan for the reduction . . . of greenhouse gas emissions" within the meaning of Guidelines section 15064.4, subdivision (b)(3), and that section therefore authorizes agencies to determine a project's greenhouse gas emissions will have a less than significant effect on the environment based on the project's compliance with the Cap-and-Trade Program. (Association of Irritated Residents v. Kern County Bd. of Supervisors (2017) 17 Cal. App. 5th 708, 743.)

As discussed in the CEQA Initial Study Chapter 2, Section XIX, Mandatory Findings of Significance, the applicable significance thresholds for the environmental resources analysis of greenhouse gases also serve as the cumulative significance thresholds. Therefore, the project greenhouse gas impacts are not considered to be significant or cumulatively considerable (CEQA Guidelines §15064 (h)(1)).

The Air District has not properly analyzed energy impacts under CEQA

Comment: Commenters stated that the Air District failed to properly analyze and mitigate energy resources, including electricity and natural gas. Commenters stated that the Final EIR did not properly analyze possible mitigation for the increase demand for electricity and natural gas, and the proposed amendments also fails due to its wasteful use of energy resources. Commenters stated that there is no specific discussion as to electricity usage that would increase from refineries operating the wet gas scrubbers.

Chevron, PBF (DB), PBF (JF), PBF (ML), PBF Energy, WSPA

Response: The 2018 EIR included a discussion and analysis of potential impacts from electricity and natural gas use. Chapter 3 of the EIR discusses potential electricity and natural gas use, and concluded that the electricity and natural gas would be used to further control emissions of criteria pollutants and assist the District in complying with ambient air quality standards; therefore, the electricity and natural gas would not be used in a wasteful or inefficient manner. The EIR included provided estimates of electricity demand associated with the operation of the air pollution control equipment that would be expected as a result of the Expedited BARCT Implementation Schedule, including wet gas scrubbers and electrostatic precipitators. As discussed in the EIR, because ESPs have a higher electricity demand than wet gas scrubbers, ESP electricity demand was considered for this analysis to provide a conservative estimate.

The Air District has not properly analyzed hazardous materials and waste impacts under CEQA

Comment: Commenters stated that the Air District has failed to fully analyze and mitigate the proposed amendments' significant hazardous materials and waste generation impacts for wet gas scrubbers. Commenters stated that the switch from an electrostatic precipitator to wet gas scrubbers will increase hazardous waste disposal from a given refinery, and the EIR does not contain an adequate discussion regarding this hazardous waste disposal issue.

Chevron, PBF (DB), PBF (JF), PBF (ML), PBF Energy

Response: The 2018 Final EIR and CEQA Initial Study address the potential impacts from hazardous waste generation and disposal. The Initial Study discusses potential impacts from the operation of controls, and concluded that controls would not be expected to generate additional hazardous or solid waste that requires disposal, and waste streams from affected facilities would be treated/disposed/recycled in the same manner as they currently are handled. Therefore, no significant impacts to solid or hazardous waste disposal facilities were expected due to the project. Facilities are expected to continue to comply with all applicable federal, state, and local statutes and regulations related to solid and hazardous wastes.

These documents have been included with the package for proposed amendment to Rule 6-5 for consideration by the Air District Board of Directors.

The Air District has not properly analyzed air quality impacts under CEQA

Comment: Commenters stated that the Air District has failed to fully analyze and mitigate significant air quality impacts for wet gas scrubbers. Commenters stated that the proposed ammonia limit could jeopardize opacity compliance and increase NOx emissions from FCCUs. Commenters state that ammonia injection reduces NOx emissions through selective catalytic reduction on catalyst fines trapped in the ESP, and replacing the ESP with a WGS will eliminate this co-benefit and result in increased NOx emissions or need to install additional NOx control technology.

Commenters stated that there is an optimal range for ammonia addition (and slip), and the limit proposed in the rule is below the optimal range and may result in actual increases of filterable PM emissions for the sake of poorly defined decreases in condensable PM emissions. Commenters stated that their review of an EIR for the installation of a wet gas scrubber in a Bay Area refinery shows that a wet gas scrubber achieves equivalent control of particulate emissions compared to electrostatic precipitators, and showed a net increase of 2.1 tons/year of PM associated with the wet gas scrubber. One commenter stated that wet gas scrubbers could result in an unintended increase in total PM emissions from the water droplets containing elevated ammonium salt levels evaporating.

Commenters stated that regenerative wet gas scrubbers use an amine solution which could result in increased toxic air contaminant emissions.

Commenters stated that the installation of wet gas scrubbers could result in a potential increase of exposures compared to current electrostatic precipitator emissions. Commenters stated that the electrostatic precipitator emits a relatively dry exhaust at high temperatures which results in PM dissipating in the upper atmosphere over the refinery, while the wet gas scrubber will have a cool, wet plume resulting in a highly visible plume that will go into the local community. Commenters stated that the Air District's model shows that a wet gas scrubber will have more ground-level exposure for equivalent emissions.

Chevron, PBF (BN2), PBF (JF)

Response: Affected refineries would be required to comply with all currently applicable NOx standards, therefore no additional NOx increases would be anticipated. The Air District also disagrees with the assertion that selective catalytic reduction or other effective NOx control systems could not be used in conjunction with a wet gas scrubber, as other wet gas scrubber installations also employ selective catalytic reduction or otherwise achieve stringent NOx limits.

While the Air District recognizes that there is an optimal ammonia injection range for filterable PM control with electrostatic precipitators, affected refineries would be required to comply with all proposed limits, including ammonia and total PM_{10} limits. As described in the Staff Report, compliance with these requirements is achievable with wet gas scrubbing controls.

The Air District disagrees with the claim that wet gas scrubbing does not achieve additional PM emission reductions compared to electrostatic precipitators. Furthermore, the Air District disagrees with the commenter's interpretation of the information in the Valero Improvement Project EIR, which indicated a net reduction in particulate emissions resulting from installation of a WGS. The increase of 2.1 tons per year of PM cited by the commenter is in reference to the Valero Improvement Project Addendum, which evaluates the changes in environmental impacts related to subsequent project amendments compared to the original project, not to the current electrostatic precipitator control levels (City of Benicia, 2008).

The commenter's claim of increased PM emissions from evaporating water droplets containing elevated ammonium salt levels is inconsistent with published literature which indicates that use of wet gas scrubbers applied to FCCU abatement, consistently results in net decreases in total PM, PM10 and PM2.5 emissions. In addition, ammonium salt formation can, and should, be addressed in any wet gas scrubber design by the manufacturer and can be effectively controlled by implementing manufacturer recommended abatement device operational practices. Any increase in ammonium salt emissions would be an indicator of a poorly designed abatement system or operation in manner inconsistent with manufacturer specifications. Ammonium salts are considered part of the total particulate catch, so all care should be exercised during the wet gas scrubber design phase to consider this particulate matter fraction in the abatement plan. The claim is also in direct conflict with the Emission Impact Report (EIR) submitted by Valero Refining Company Benicia Refinery in support of the Valero Improvement Project in May 2008, which indicated a net reduction in particulate emissions resulting from installation of a wet gas scrubber (City of Benicia, 2008).

The claim of increased toxic air contaminant emissions from the use of amine solution in regenerative wet gas scrubbers is not supported or substantiated. In addition, affected refineries would be required to comply with all currently adopted and applicable regulations and limits on toxic air contaminants. Therefore, no additional impacts would be anticipated.

The Air District recognizes that dispersion characteristics of exhaust from electrostatic precipitators and wet gas scrubbers differ, however, significant emissions reductions are achievable through the use of a wet gas scrubber, as described in the Staff Report. As shown in the Staff Report and PM modeling results, the substantial emission reductions achieved through wet gas scrubbing result in overall net reductions in exposure.

City of Benicia, 2008. Valero Improvement Project – Addendum to VIP EIR, SCH No. 2002042122. June.

The Air District has not properly analyzed aesthetics impacts under CEQA

Comment: Commenters stated the Air District has failed to analyze the proposed amendments' significant aesthetics impacts for wet gas scrubbers. Commenters stated that the EIR fails to account for changes to aesthetics that could result from the increased visibility of the new wet gas scrubber plume.

Chevron, PBF (JF)

Response: The 2018 Final EIR and CEQA Initial Study address potential aesthetic impacts from the installation of control equipment, including wet gas scrubbers. The Initial Study discusses potential impacts from the operation of controls, and found that while equipment may be visible outside of the existing industrial facilities, these facilities are located in industrial areas which do not have scenic views or scenic resources. Therefore, they are not expected to have significant adverse aesthetic impacts to the surrounding community, and would not be expected to block any scenic vista, degrade the visual character or quality of the area, or result in significant adverse aesthetic impacts.

Feasibility of Controls and Proposed Limits

Wet gas scrubbing controls are not technically feasible

Comment: Commenters stated that there is no feasible space at the PBF Martinez Refinery to install a wet gas scrubber, and that installation is therefore not technically feasible. Commenters stated that the District has not identified a feasible location for the installation of a wet gas scrubber, or how to relocate equipment that would need to be moved to make room for a scrubber. Commenters stated that the Air District has misconstrued the purpose of hypothetical demolition and relocation costs provided by industry by concluding that it is possible to demolish and relocate equipment. Commenters stated that the proposed rule must consider each refinery's specific operations and configurations.

PBF (JF), PBF (ML), PBF Energy

Response: Though space is at a premium at refinery sites, the lead time given for implementation of the proposed amendments allows affected refineries to adequately plan, engineer, and design control systems and complete installations necessary to comply with the limits. Space considerations at the PBF Martinez Refinery may require the demolition or relocation of certain equipment to install a wet gas scrubbing system. This is why additional costs for this work were included in the Air District's cost analysis and estimates.

Wet gas scrubbers have been implemented at other refineries with space constraints through different available engineering and design solutions. Notably, the installation of a wet gas scrubber at the Valero Benicia Refinery was constrained by a lack of space, with the scrubber planned to be located on a site with an existing slope. This hillside area was cut and filled, and retaining walls were added to create a new 150,000 square foot pad for the scrubber and other equipment in the abatement train (City of Benicia, 2008; Eichleay, 2021). Each affected refinery will determine what specific abatement system design parameter or configuration is most appropriate to comply with the proposed amendments at their respective site.

City of Benicia, 2008. Valero Improvement Project – Addendum to VIP EIR, SCH No. 2002042122. June.
Eichleay, Inc., 2021. "Flue Gas Scrubber Project - Benicia, CA". https://www.eichleay.com/petroleum-refining. Accessed April 2021.

Proposed limits are not achievable

Comment: Several commenters stated that the Air District has not demonstrated that the proposed limits are achievable, and do not meet the requirements of BARCT. Commenters stated that the source test data provided in Appendix B show that multiple facilities with wet gas scrubbers do not reliably meet the proposed limit, and do not include facilities in California. Commenters stated that source tests from other FCCUs with wet gas scrubbers have been omitted from Appendix B, and provide examples of other wet gas scrubbers that do not meet the proposed limit or only meet the limit under certain load conditions. Commenters assert there is a low probability that the proposed limit can be achieved by wet gas scrubbing, and data from Appendix B should be made available so they can be independently evaluated.

Commenters stated that installing a wet gas scrubber does not guarantee compliance with the limits, as some facilities with wet gas scrubbers have PM emissions much higher than the proposed standard. Commenters stated that multiple source tests at the Valero Benicia Refinery exceeded the proposed limit.

Chevron, PBF (DB), PBF (HD), PBF (JF), WSPA

Response: The proposed total PM_{10} emission limit reflects levels of stringency that have been achieved at multiple FCCUs through wet gas scrubbing controls. Staff reviewed available source test data from fluidized catalytic cracking units at other refineries throughout the US (a summary of this data is provided in Appendix B). Staff reviewed data from 20 FCCUs, including 9 units with ESPs as primary PM abatement and 12 units with wet gas scrubbers as primary PM abatement (note that one FCCU had installed a wet gas scrubber in 2018, and staff reviewed data from this source both before and after this installation). The data indicated that seven of the 20 FCCUs achieved PM emission levels below the proposed PM limit of 0.010 gr/dscf at 5% oxygen (including six of the reviewed FCCUs abated by WGS, and one FCCU abated by ESP).

The performance of any abatement device is dependent on the design and operation of each specific unit. Optimal performance of control systems can depend on many factors, such as equipment type and design, adequate size/capacity, and proper operation and maintenance. Source test data from FCCUs throughout the US indicates that the proposed limits are achievable, and have been demonstrated at several different units, including at the Valero Benicia Refinery within the Air District's jurisdiction. Although there are also units with test data that do not meet the proposed limit, the less effective performance of some wet gas scrubbing units does not categorically demonstrate that a more stringent level is not feasible or achievable.

Regarding source test data at FCCUs abated by a wet gas scrubber that do not demonstrate emissions below the proposed PM limit of 0.010 gr/dscf at 5% oxygen, it is important to note that as far as the Air District is aware, these FCCUs are not subject to that regulatory limit. Wet gas scrubbers have commonly been required as means of controlling sulfur dioxide emissions and therefore may not be designed and optimized for control of PM. The fact that an FCCU is not achieving PM emissions below 0.010 gr/dscf is therefore not necessarily an indication that compliance is infeasible at that FCCU. By contrast, a source test showing operation below the limit is an indication of feasibility regardless of whether the limit is a regulatory requirement at that FCCU.

The Air District continued to gather data and information on controls and emissions performance throughout this rule development process. Although there may be relevant data from wet gas scrubbers at FCCUs that were not discovered during this process, the Air District expended considerable effort in its search and solicited input from all stakeholders. No relevant data was deliberately excluded from consideration. Emissions performance of different controls were discussed with the affected refineries and industry association in meetings of the Refinery Rules Technical Working Group in 2019, and input was solicited from those stakeholders on other sources of information on emissions performance at that time. Thus there has been a robust review of available emissions performance data in the development of the proposed amendments. All data included in Staff Report Appendix B are already publicly available documents.

Table in Appendix B is intended to provide information on other refineries outside of the San Francisco Bay Area. Outside of the San Francisco Bay Area, only one other refinery in California operates an FCCU abated by a wet gas scrubber system (ConocoPhillips Los Angeles Refinery – Wilmington, CA). In addition, source testing at the Valero Benicia Refinery within the Air District's jurisdiction, which operates an FCCU abated by a wet gas scrubbing system, has also shown achievement of PM emission levels below the proposed PM limit. While some individual source tests at the Valero Benicia Refinery resulted in emission levels at or above the proposed limit, the proposed total PM_{10} limit is a long-term limit, and compliance determinations would be based on the average of multiple source tests. The long-term average of source tests at the Valero Benicia Refinery indicates that the FCCU and abatement system would be expected to comply with the proposed amendments.

Proposed timelines are not feasible

Comment: Commenters stated that wet gas scrubbing systems would take many years to build and could not be installed within the next five years. One commenter stated that the installation of a wet gas scrubber would take at least eight years to complete design/engineering, CEQA requirements, permitting, procurement/fabrication/delivery, logistics, construction, and testing, and may be potentially longer due to coordination with planned turnaround outages.

PBF (JF), PBF (RM)

Response: While substantial time may be required for the planning, design, permitting, scheduling, construction, and installation of wet gas scrubbing systems at the affected refineries, real world experience indicates that the timeline in the proposed amendment for implementation of a wet gas scrubber is reasonable and achievable. As discussed in the Staff Report, other installations of wet gas scrubbers have been implemented in comparable timeframes. For example, applications for use permits and Air District permits for the installation of the wet gas scrubber at the Valero Benicia Refinery were originally submitted in 2002 as part of the Valero Improvement Project. The Valero Improvement Project involved several components, and construction of the various elements occurred over several years following approval. Planning and permitting of the project began in 2002, construction of the wet gas scrubber abatement train took place from 2008 through 2010, and operation commenced in 2011 (Valero Benicia Refinery, 2012). The ConocoPhillips Los Angeles Refinery (Wilmington) also installed a wet gas scrubber at the fluidized catalytic cracking unit to meet the requirements of South Coast AQMD Rule 1105.1. The Rule was adopted in 2003, a CEQA Notice of Preparation for the project was issued in 2006, and construction occurred from 2007 through 2008 (SCAQMD, 2010). Construction of a wet gas scrubber at the HollyFrontier Cheyenne Refinery FCCU occurred from 2014 through 2015, with planning of the project starting in 2011 (HollyFrontier Cheyenne Refinery, 2015; Orr, 2015).

The Air District recognizes that completion of a major construction project such as a wet gas scrubber involves steps, such as permitting from county building departments, that are to some extent beyond the control of the refinery. The Health & Safety Code Section 42350 et seq. provides for extension of a compliance date through the issuance of an air district hearing board variance where it can be shown that delay in compliance is due to reasons beyond the reasonable control of the refinery. Variances are generally limited to one year in duration, but may be longer. The Air District believes it is better to address circumstances beyond the reasonable control of the refinery if and when those circumstances arise rather than build extra time into the initial compliance schedule in anticipation that such delays may happen.

Valero Benicia Refinery, 2012. Valero Improvement Project (VIP) Construction Report for the period ending June 30, 2012. August.

South Coast AQMD, 2010. Final Staff Report SOx RECLAIM, Part 1: BARCT Assessment & RTC Reductions Analysis. November.
HollyFrontier Cheyenne Refinery, 2015. "Cheyenne Can Breathe Easier." September.
Orr, Becky, 2015. "Massive scrubber at HollyFrontier will cut pollution, stench," Wyoming Tribune Eagle. April 30.

Proposed timelines should be accelerated

Comment: Commenters stated that compliance deadlines in the proposed amendments should be accelerated to meet the Advisory Council's urgency findings and require the earliest possible date. Commenters suggested the Air District consider shortening the compliance timeframe to provide needed protection in overburdened communities.

350 Bay Area, Community Energy reSource, CBE

Response: The Air District recognizes the need to achieve emission reductions and clean air benefits throughout the Bay Area, including in disproportionately impacted communities. As discussed in the Staff Report, the anticipated installation and implementation of controls may involve substantial time and effort for planning, design, engineering, and scheduling, in addition to the construction of these systems. The effective date in the proposed amendments reflects the earliest feasible date of implementation. As discussed in the Staff Report, other installations of wet gas scrubbers at refineries have required similar timeframes for implementation.

The proposed total PM10 limit cannot be met during startup and shutdown operations

Comment: One commenter stated that the proposed amendments remove the exemption for startup and shutdown operations for the proposed total PM10 limit, and the limit cannot be met during startup and shutdown operations.

WSPA

Response: The startup and shutdown exemptions in the proposed amendments are intended to apply to short-term limits, including the proposed daily ammonia limit and proposed short-term seven-day rolling average emission limit for sulfur dioxide, as described in the proposed amendments Section 6-5-112 and the Staff Report. Such exemptions are not appropriate for long-term limits, including the proposed long-term 365-day rolling average emission limit for sulfur dioxide and proposed total PM10 limit.

Ammonia and sulfur dioxide limits are unnecessary

Comment: Commenters stated because the focus of the rule is particulate matter, limits on ammonia and sulfur dioxide are unnecessary.

Chevron, PBF (ML)

Response: Ammonia and sulfur dioxide contribute to the formation of particulate matter. Control of these components ensures particulate matter is adequately controlled. In addition, continuous monitoring requirements and short-term limits for ammonia and sulfur dioxide ensure that particulate matter emissions are minimized and controlled on an ongoing basis.

Health Impacts

The Air District's health analysis is not transparent

Comment: Commenters stated that the Air District's presentations to the public regarding the science of PM2.5 health effects has not been sufficiently transparent. Commenters stated that the Health Impacts Analysis as presented demonstrates a lack of transparency, and fails to present the full picture, including model uncertainties, to the Board and the public.

One commenter stated that the weakness/unreliability of the correlations is not transparent for the graph showing an association between annual PM2.5 and annual mortality. One commenter stated that the Air District does not provide sufficient information regarding the risk coefficients from the epidemiology studies, PM concentrations, or population inputs so that its analysis could be replicated or independently validated.

One commenter stated that BAAQMD has not provided sufficient information to assess the Health Impact Analysis, including data inputs and the full set of modeling results from the BenMAP analysis, including: inputs for population estimates, PM2.5 concentrations in each modeled scenario (baseline and controlled conditions), concentration-response functions (CRFs), health incidence data, and results associated with the distribution of potential impacts and the percent of baseline incidence.

One commenter stated that the District fails to present the range of uncertainty in the Health Impact Analysis, instead presenting single values as if they were certain. The commenter stated that BenMAP analyses typically include an assessment of the statistical uncertainty associated with the concentration-response functions, and provides a distribution of impacts from which uncertainty bounds can be obtained. The commenter stated that confidence intervals would present the full range of potential impacts, possibly including no benefit from the Proposed Amendments.

One commenter stated that BenMAP analyses assume a log-linear response between exposure and health effects, and models this response without consideration for a threshold below which effects may not be measurable and does not consider, for example, a health effect threshold as a lower bound (such as the NAAQS). The commenter stated that some of the concentration-response functions used in the Health Impact Analysis (i.e., for mortality based on a meta-analysis) are not well justified, and the District fails to discuss the impact of using different concentration-response functions.

Chevron, PBF (JF)

Response: The US EPA's Policy Assessment for Review of the PM NAAQS is intended to serve as a bridge between science and rulemaking, interpreting the findings of the US EPA Integrated Science Assessment with respect to existing and potential policy. This document (EPA, 2018) provides a great deal of detail supporting the fact that the current PM NAAQS may not be sufficiently health protective (see Section 3.3.2.2., Tables 3-7 and 3-8). Section 3.3.3. summarizes the document's conclusions, stating that "the current primary PM2.5 standards could allow a substantial number of PM2.5-associated deaths in the U.S."

With respect to the transparency of PM2.5 health impacts, the Air District's Advisory Council has held 10 public meetings related to various aspects of the science of PM2.5 health impacts, starting on March 11, 2019, and concluding on December 16, 2020, with a joint meeting of the Advisory Council and the Air District Board of Directors. The Air District has used publicly available tools approved by the US EPA to estimate health impacts and have presented methods and findings at public meetings of the Stationary Source Committee and at a Public Workshop on February 4, 2021.

Details of the air quality health impact analysis are reported in Appendix A.2 (Chevron Richmond Refinery) and in Appendix A.3 (PBF Martinez Refinery). These two appendices provide the details of the application of the US EPA's Benefits Mapping and Analysis Program-Community Edition (BenMAP-CE or BenMAP), the preparation of the modeling-based PM2.5 concentrations, descriptions of the population data used, and the health endpoint studies applied. The Air District has made these modeled concentration datasets available via public records requests and the publicly available BenMAP model includes the needed population information and health response functions such that experienced modelers could repeat the Air District's process and check findings. The Air District continues to make available all datasets requested in accordance with Public Record Act requirements.

Apart from the modeled PM2.5 concentrations, several key inputs are publicly available and accessible through the freely downloadable BenMAP-CE platform. These include: population estimates; baseline health incidence data; and concentration-response functions (CRFs). In addition to the extensive documentation included in Appendices A.2 and A.3, to the best of our knowledge, the Air District has provided the commenter with all electronic modeling files they have requested via public records requests and held video conference calls to answer questions related to such requests.

The Air District focused on presenting ranges of estimates for mortality and cardiovascular impacts, which together dominate the bottom-line valuations. These ranges reflect the impact of using different response functions (i.e., relying on different studies). Additional sources of uncertainty, including sources that cannot be feasibly quantified, have been acknowledged in Section V.E.3, "Limitations and Comparability", of the Staff Report. The Air District has responded to recently submitted public records requests regarding BenMAP output, which includes confidence intervals associated with the modeled response functions. None of those confidence intervals include zero; as such, all reject the possibility of "no benefit". For reference, please see the USEPA BenMAP technical documentation.

The BAAQMD Advisory Council Particulate Matter Reduction Strategy Report, Particulate Matter: Spotlight on Health Protection, in statement PMRS 5 (page 6), found that "there is no known threshold for harmful PM2.5 health effects; thus, it follows that additional reductions of PM2.5 concentrations will achieve additional public health benefits." This statement is supported by the U.S. EPA's 2019 Integrated Science Assessment for Particulate Matter. Section 1.5.3

explains the concentration-response relationship observed between PM2.5 exposure and health effects, stating that recent studies "continue to provide evidence of a linear, no-threshold relationship between both short- and long-term PM2.5 exposure and several respiratory and cardiovascular effects, and mortality." Sections 11.1.10 (short-term exposure) and 11.2.4 (long-term exposure) provide further discussion of this concentration-response relationship, evidence regarding its linearity, and the lack of a PM2.5 threshold below which deleterious health effects are not observed.

In the context of this specific assessment, please also note that BAAQMD has modeled changes in PM2.5 within a policy-relevant range that is approximately 10 $\mu g/m^3 \pm 10\%$. Effects within this policy-relevant range have been the subject of many studies; for reference, please see the meta-analysis that BAAQMD included in its evaluation (Vodonos et al., Environmental Research, 166:677-689, 2018, Figure 1). For the purposes of this assessment, the possibility of a threshold outside of this range is moot. The relevant issue is the effect of moving from 10 $\mu g/m^3$ to 9 $\mu g/m^3$, not moving from 1 $\mu g/m^3$ to zero.

Regarding the selection of health studies and response functions used in the Staff Report, BAAQMD was guided by four aims: (1) coverage of the suite of studies typically selected by US EPA for regulatory impact analyses; (2) coverage of California-specific findings; (3) balanced and comprehensive coverage of a wide range of recent studies on the most highly-valued endpoint (mortality); and (4) interests and concerns raised by the Board and by public commenters. To satisfy the second and third aims, BAAQMD evaluated a California-specific study (Jerrett et al., Am J Respir Crit Care Med, 188(5):593-599, 2013) as well as a meta-analysis of mortality (Vodonos et al., Environmental Research, 166:677-689, 2018). The relative risk estimates for mortality taken from those were, respectively, 1.06 for a 10 $\mu g/m^3$ increase in PM2.5 and 1.0129 for a 1 $\mu g/m^3$ increase in PM2.5. However, including those studies did not affect the overall results (i.e., reported ranges). The minima and maxima for reported ranges turned out to be determined by the set of studies typically selected by US EPA, which are well justified by EPA documentation in support of numerous regulatory analyses.

EPA, 2018. Integrated Science Assessment for Particulate Matter. October.

PM health impacts are overestimated

<u>Comment</u>: Commenters stated that there are no studies showing the direct health impacts from the Bay Area FCCU PM emissions modeled. Once commenter stated that the report should include data on the FCCU mass composition, chemical composition, and an assessment of the toxicological differences between FCCU particulate composition and grass fire, combustion engine, woodsmoke, and cooking particulate. One commenter stated that condensable and secondary PM compounds have not been shown to have significant health impacts.

One commenter stated that BAAQMD fails to present any discussion or acknowledgment of the limitations and uncertainties associated with the epidemiological studies that are the basis of the Health Impact Analysis. The commenter states that causality is difficult to establish because epidemiology studies often have limitations when accounting for confounders and biases, most importantly inadequate individual exposure estimates and the inability to control for many factors that could explain the association between PM2.5 and mortality, such as lifestyle factors like smoking. The commenter states that the speciated components of PM that may be associated with particular adverse health effects are yet unknown, but the analyses in Appendix A.2 assume that all PM species are equally toxic, which makes it a very conservative analysis.

Commenters stated that the Air District is exaggerating and misstating the anticipated health benefits of the proposed regulation, and stated that the science of health effects (from PM) is not exact. The commenter stated that the NAAQS value of 12 µg/m3 was upheld by the EPA in 2012, and is also the California Ambient Air Quality Standards set by California's Office of Environmental Health Hazards Assessment. The commenter stated that the proposed amendments would have no appreciable benefit to measurable PM levels in the Bay Area, which are already well below protective standards in the Martinez area.

One commenter stated that the vast majority of refinery workers and residents in Martinez have not seen ill health impacts; other factors and lifestyle choices may be more responsible for health impacts across the broad population.

Chevron, PBF (DB), PBF (JF), PBF (JS), PBF (ML), PBF (PO), S. Rosenblum

Response: The BAAQMD Advisory Council Particulate Matter Reduction Strategy Report, Particulate Matter: Spotlight on Health Protection, in statement PMRS 9 (p. 7), found that while some species of PM may be more dangerous than others, as of yet, no PM species can be exonerated. This statement is supported by the U.S. EPA's 2019 Integrated Science Assessment for Particulate Matter, which reviewed the body of new PM research since 2009. Section 1.5.4 reviews the evidence regarding health effects of specific components or sources of PM. The authors conclude that "the evidence does not indicate that any one source or component is consistently more strongly related with health effects than PM2.5 mass."

Regarding causality: EPA's final Integrated Science Assessment (ISA) for Particulate Matter (EPA/600/R-19/188) finds that there is a causal relationship between PM2.5 and mortality, the health endpoint that constitutes over 90 percent of the valuation of BAAQMD-modeled health impacts. The same also finds that PM2.5 causes impacts on cardiovascular health; cardiovascular impacts are the second most highly valued endpoint in BAAQMD's assessment. The scientific consensus is clear: PM2.5 causes these health impacts.

The Preamble to the EPA Integrated Science Assessment explains the methodology for their Framework for Causal Determinations as follows: "In the ISA, the U.S. EPA assesses the body of relevant literature, building upon evidence available during previous NAAQS reviews, to draw conclusions on the causal relationships between relevant pollutant exposures and health or environmental effects. ISAs use a five-level hierarchy that classifies the weight of evidence for causation. This weight-of-evidence evaluation is based on the integration of findings from various lines of evidence from across health and environmental effect disciplines that are integrated into a qualitative statement about the overall weight of the evidence and causality." EPA is not relying on any one study for their causal determinations, but integrating results over many studies across disciplines.

The BAAQMD Advisory Council Particulate Matter Reduction Strategy Report, Particulate Matter: Spotlight on Health Protection, in statements PMRS 1-6 (pp. 6-7), found that the NAAQS value of 12 µg/m³ is not health protective, and that PM is the most important health risk driver in Bay Area air quality.

Health impacts from causes other than PM are outside the scope of BAAQMD's supplemental assessment. The scientific studies on which BAAQMD is relying have estimated impacts from PM after adjusting for other factors.

PM health impacts are underestimated

Comment: One commenter stated that health benefits from reducing PM are known to be greater than those estimated by staff, and many other health impacts linked to PM exposure are not included in the modeled health benefits. The commenter stated that the Advisory Council's strong findings on PM should be included and explained for the Board of Directors' consideration of the proposed amendments to Rule 6-5.

350 Bay Area

Response: Regarding the selection of health studies and response functions used in the Staff Report, BAAQMD was guided by four aims: (1) coverage of the suite of studies typically selected by US EPA for regulatory impact analyses; (2) coverage of California-specific findings; (3) balanced and comprehensive coverage of a wide range of recent studies on the most highly-valued endpoint (mortality); and (4) interests and concerns raised by the Board and by public commenters. The Advisory Council's findings are discussed and referenced throughout the Staff Report.

Socioeconomic Impact Analysis

Socioeconomic impacts are underestimated

Comment: Several commenters stated that potential socioeconomic impacts of the proposed amendments are significant and underestimated, and the Air District has not performed a fair and accurate assessment of the socioeconomic impacts. Commenters stated that the threshold used to evaluate the significance of potential socioeconomic impacts is arbitrary, and refinery economics cannot be based on corporate profit. Commenters also stated that the COVID-19 pandemic has heavily impacted the petroleum industry, and these impacts should be taken into account when estimating future revenue.

Commenters stated that the potential measures described to mitigate the significant socioeconomic impacts are not feasible. Commenters stated that the ability to pass through costs to consumers are determined by market forces for feedstocks and products at the local and global scale, not by the percentage of corporate profits. Several commenters asserted that the PBF Martinez Refinery would be forced to closed, resulting in much higher job losses than estimated by the Air District and impacts to other businesses.

Commenters stated that the Air District is not making a good faith effort to minimize these socioeconomic impacts as required under the California Health and Safety Code Section 40728.5.

Chevron, Martinez Chamber, PBF (JF), WSPA

Response: The Socioeconomic Impact Analysis includes an evaluation of the potential significant socioeconomic impacts as required by California Health and Safety Code Section 40728.5, and describes the methodologies, data sources, and assumptions used in the analysis. As described in the Socioeconomic Impact Analysis, the proposed amendments to Rule 6-5 have the potential to result in significant socioeconomic impacts.

State law does not require an air district to use a threshold for significance as part of the Socioeconomic Impact Analysis. The Air District believes the 10 percent threshold for significance is a useful analytic tool even if it is not required, and serves as a reasonable benchmark for significant impacts. The 10 percent threshold was reviewed and validated by Dr. Peter Berck, who served as a Professor in Agriculture and Resource Economics in the UC Berkeley College of Natural Resources until 2018. Dr. Berck wrote extensively on environmental policy and had recently developed economic models used by both the Air Resources Board and the State Department of Finance. The Air District uses standard methodologies and publicly reported data to provide a consistent and standardized framework for analyzing and comparing different rules, amendments, control measures, and other emission reduction programs.

As discussed in the Socioeconomic Impact Analysis, with the current recession starting in 2020 due to the COVID-19 pandemic, it may be expected that refinery production levels will be affected, with associated financial impacts and job reductions at the facilities. It is difficult to predict the time frame for recovery from this current recession related to the COVID-19 pandemic, as there remains much uncertainty on the ability of consumers and businesses to resume previous levels of economic activity given the significant loss of income. However, the implementation costs associated with amendments to Rule 6-5 are not scheduled to occur for several years, at which time the economy is projected to recover to near pre-pandemic levels. Most economic forecasts project that the US economy will have substantially recovered from the COVID-19 related economic downturn early in this time frame. For example, in February 2021, the Congressional Budget Office projected that real GDP will recover to pre-pandemic levels by the middle of 2021, and that employment levels will recover in 2024 (CBO, 2021). Therefore, the refinery economic data prior to the recession is a more relevant benchmark for the impacts of the proposed compliance costs, and the socioeconomic analysis is based on financial indicators from the refinery in 2019.

The Socioeconomic Impact Analysis indicated that the profitability of the affected refineries would be significantly impacted, and includes a discussion of potential adjustments that may be considered by the affected refineries to reduce these impacts to less than significant levels. California Health and Safety Code Section 40728.5 identifies the loss of jobs as a potentially significant socioeconomic impact and the Socioeconomic Impact Analysis identifies the incremental loss of jobs that could occur under one possible mitigation scenario. In another scenario, the proposed amendments could result in gas price increases. The affected facilities have not provided sufficient data to evaluate which potential mitigation measures they would be most likely to adopt.

The Socioeconomic Impact Analysis indicates that while the costs of the rule would significantly impact profitability of the affected refineries, the facilities would remain able to generate profits. Therefore, while the analysis indicates that impacts would be significant and business adjustments would be anticipated, the analysis does not assume that the facilities would close as a result of the proposed amendments. While the analysis discusses some of the potential adjustments that the affected facilities may consider, staff cannot predict individual business decisions or actions that the affected facilities may elect to take. These decisions may involve a number of other considerations beyond the scope of the proposed amendments. If management at PBF Martinez decided to close the facility, the closure could eliminate an estimated 650 jobs directly at the plant and additional jobs from supplier companies through multiplier effects. Again, based on the available data, the Socioeconomic Impact Analysis concludes that the facilities could still maintain some level of profitability after absorbing the identified compliance costs associated with the proposed amendments, and would not be expected to result directly in the plant closure.

Throughout the rule development process for amendments to Rule 6-5, staff has presented information, discussed, and solicited public input on multiple control options with different potential socioeconomic impacts. The consideration of these different control options with different impacts enables the Air District Board of Directors to make a good faith effort to minimize these impacts while considering the goals and purpose of the proposed amendments.

Congressional Budget Office (CBO). 2021. An Overview of the Economic Outlook: 2021 to 2031. https://www.cbo.gov/publication/56965. February 1.

Socioeconomic impacts are overestimated

Comment: Commenters stated that the significance threshold of 10 percent of profit loss is outdated and arbitrary, and results in potential job loss estimates that are not substantiated. Commenters also stated that fuel cost impacts are small and within daily price variations. Commenters stated that potential job creation from the installation of wet gas scrubbers should be estimated and included in the analysis.

One commenter also stated that profits at the Chevron Richmond Refinery are underestimated, and higher refinery profit ratios should be assumed for the refinery. The commenter stated that average refinery profits over multiple previous years are higher than the 2019 profits and should be used in the analysis instead of the single year of 2019. The commenter also stated that the analysis does not account for the value of tax write-offs.

350 Bay Area, CBE, J. Kilbreth

Response: As noted above, the Air District is not required to use any particular threshold of significance in the Socioeconomic Impact Analysis. A significance threshold is intended as a useful analytic device.

Comments on the relative price increases of gasoline are consistent with the statements in the Socioeconomic Impact Analysis that note the potential price increases are well within the level of gas price fluctuations that normally occur due to changes in demand and supply factors annually. While the analysis discusses some of the potential adjustments that the affected facilities may consider, the Air District cannot predict individual business decisions or actions that the affected facilities may elect to take. These decisions may involve a number of other considerations beyond the scope of the proposed amendments.

The Socioeconomic Impact Analysis notes that the cost to purchase and install the required control technologies would translate to added jobs and income in the Bay Area region. This construction-related labor would be temporary, and estimates of construction-related labor for the installation of control equipment would be uncertain at this point prior to the specific design and construction planning of any projects. For example, a major improvement project at Valero Benicia Refinery, which included the installation of a WGS and several other major capital improvements, was estimated to require a work force of roughly 200 construction employees. (City of Benicia, 2002). An improvement project at the ConocoPhillips Los Angeles Refinery in Wilmington also included the installation of a WGS and wet ESP among other improvements. The environmental analysis for that project did not estimate the total construction workforce anticipated, but estimated a maximum of 100 workers per day traveling to the site during construction (South Coast AQMD, 2007).

The Socioeconomic Impact Analysis describes the methodology and data sources used to develop the estimates of annual profits of each affected refinery. The estimates rely heavily on data available from a variety of sources, including Corporate reports filed with the Securities Exchange Commission (SEC), data from the US Census County Business Patterns and Census of Manufactures, the US Internal Revenue Service, and reports published by the California Energy Commission (CEC) that track gasoline prices and cost components as well as refinery production levels. The information and data used in this analysis do not support the assertion that refinery profit ratios should be higher than those estimated, nor do they support the assertion that the Chevron Products Richmond refinery earnings per barrel are significantly higher than other Chevron refineries. However, there are uncertainties and limitations inherent in the development of profit estimates based on the publicly available data. Air District staff and contractors rely on standard methodologies and publicly reported data to provide a consistent and standardized framework for analyzing and comparing different rules, amendments, control measures, and other emission reduction programs.

Refinery profits and financial performance vary from year to year. However, there has been an overall declining trend in California gasoline demand since 2017, and demand is not forecasted to increase over the next several years (Schremp, 2021). Therefore, staff believes information from the 2019 provides a more reasonable estimate of performance than the previous years of higher gasoline demand.

The Socioeconomic Impact Analysis notes that the estimates do not include potential tax savings associated with the depreciation of capital expenditures. The EPA Air Pollution Control Cost Manual notes that depreciation of capital can factor into potential tax savings, however, taxes are not uniformly applied, and subsidies, tax moratoriums, and deferred tax opportunities distort how the direct application of a tax works. Because the application of these potential tax savings can be speculative and uncertain, the estimates in the analysis conservatively do not include potential tax savings, and notes this in the report.

City of Benicia, 2002. Valero Improvement Project – Draft EIR, SCH No. 2002042122. October. SCH No. 2006111138
Schremp, Gordon (California Energy Commission). 2021. BAAQMD Board of Directors Special Meeting Presentation – "Transportation Fuels Trends, Jet Fuel Overview, Fuel Market Changes & Potential Refinery Closure Impacts". May.
South Coast AQMD, 2007. Final EIR for ConocoPhillips Los Angeles Refinery PM10 and NOx Reduction Project, SCH No. 2006111138. June.

Socioeconomic impacts to small businesses were not analyzed

Comment: Commenters stated that the socioeconomic analysis does not support the finding that small businesses are not disproportionately impacted by the proposed amendments. Commenters stated that there is no analysis for impacts on small businesses that rely on gasoline for transportation and energy needs.

Chevron

Response: The discussion of small business disproportionate impacts is intended to apply to the three refineries affected by the proposed amendments to Rule 6-5. While the State has used the $10 million annual sales threshold as one measure to define small business, Government Code Section 11436.3 (January 1, 2017) authorizes the use of a consolidated definition of small business for the purposes of evaluating the impacts of state regulation on businesses within the state. This section uses three criteria:

1) Independently owned and operated.
2) Not dominant in its field of operation.
3) Has fewer than 100 employees.

The three affected refineries are all owned by national corporations and are each estimated to have more than 600 employees. Therefore, they do not qualify as small businesses under California law per California Government Code Section 11346.3.

Socioeconomic impacts do not account for costs related to ESP explosion risk

Comment: Commenters stated the analysis for the proposed amendments and control options should include costs related to ESP explosion risk under the Less Stringent Control Option.

350 Bay Area, Community Energy reSource

Response: The presumption of a catastrophic event such as an ESP explosion is not a standard practice in analyzing potential socioeconomic impacts of a proposed rule or amendment. As discussed in the Staff Report, standard industry practices and vendor safety recommendations, including frequent inspection and maintenance, air filter cleaning, use of hydrocarbon sensors, and electronic controls for process automation can reduce risks from operation of electrostatic precipitators. An investigation of the February 2015 incident at the ExxonMobil Refinery located in Torrance, California by the U.S. Chemical Safety and Hazard Investigation Board identified weaknesses in the refinery's process safety management system and found that a number of standard industry and safety practices were not followed, contributing to the incident. The analysis assumes that a facility would follow all applicable regulations and standard industry and safety practices. Staff also notes that risks from ESP explosion were discussed in the 2018 Environmental Impact Report for the AB 617 Expedited BARCT Implementation Schedule, and hazard impacts related to ESP controls were found to be less than significant.

Proposed amendments may cause significant impacts on the supply of aviation jet fuel and increase fuel imports

Comment: Several commenters stated that the proposed amendments may cause significant issues for the viability of the refining industry and impacts on the supply of conventional aviation jet fuel needed for airline operations.

Commenters stated that the PBF Martinez Refinery supplies 67% of the aviation jet fuel used in Bay Area airports, and closure of the facility would have impacts on the supply of jet fuel. Several commenters stated that if refineries in the Bay Area are decommissioned due to regulations, fuel will be produced and imported from other countries with less stringent safety and environmental standards.

Airlines for America, EBLC, Mayor of Martinez, PBF (DB), PBF (JF), PBF Energy

Response: The Socioeconomic Impact Analysis indicates that while the costs of the rule would significantly impact profitability of the affected refineries, the facilities would remain able to generate profits. Therefore, while the analysis indicates that impacts would be significant and business adjustments would be anticipated, the analysis does not assume that the facilities would close as a result of the proposed amendments. While the analysis discusses some of the potential adjustments that the affected facilities may consider, it is not possible to predict individual business decisions or actions that the affected facilities may elect to take. These decisions may involve a number of other considerations beyond the scope of the proposed amendments.

Based on the available data, the Socioeconomic Impact Analysis concludes that the facilities could still maintain some level of profitability after absorbing the identified compliance costs. However, CEC staff presented information at the May 5, 2021 Special Meeting of the Air District Board of Directors on potential impacts of refinery closures, including potential impacts on jet fuel (Schremp, 2021). The presentation indicated that a near-term premature refinery closure could result in market impacts. Using market impacts associated with the 2015-2016 outage of the ExxonMobil Torrance Refinery in Southern California as a reference for potential impacts, a premature refinery closure in the near-future could result in greater impacts compared to the 2015-2016 outage, as spare refinery production capacity has been diminished due to the idling of the Marathon Martinez Refinery, the balance of gasoline and diesel supply and demand has tightened, and a potential return to higher jet fuel demand levels may remove additional flexibility from the marketplace. The 2015-2016 outage of the ExxonMobil Torrance Refinery in Southern California also resulted in a price spike of sufficient magnitude to incentivize the over production by other California refiners, as well as increased imports of more expensive gasoline and blending components at a higher level for a sustained period of time. Aside from a potential premature refinery closure over the near-term, however, continued demand declines for gasoline and fossil diesel fuel over the long-term can create conditions of oversupply that could result in additional refinery consolidation. With respect to the supply of jet fuel, the CEC presentation (Schremp, 2021) included information about the jet fuel distribution system which indicated that Bay Area airports are supplied with jet fuel through a pipeline system that connects to every Bay Area refinery. This provides some flexibility in supplying that product, including from a refinery that is not impacted by the proposed rule amendments because it does not have any FCCU (Phillips 66 in Rodeo) and a refinery not expected to incur significant additional costs as it has already installed a wet gas scrubber (Valero in Benicia).

Schremp, Gordon (California Energy Commission). 2021. BAAQMD Board of Directors Special Meeting Presentation – "Transportation Fuels Trends, Jet Fuel Overview, Fuel Market Changes & Potential Refinery Closure Impacts". May.

Statutory Requirements

The Air District has not demonstrated authority to adopt the proposed amendments

Comment: Commenters stated that the Air District has not adequately demonstrated its authority to adopt the proposed amendments, and the Air District cites no specific authority to impose emissions limitations on FCCUs at Bay Area refineries. Commenters state that the Air District fails to mention AB 617 and California Health and Safety Code 40920.6.

PBF (JF), WSPA

Response: Relevant authority to adopt the proposed amendments are cited as appropriate in the Staff Report and in these responses to comments. AB 617 and Health & Safety Code Section 40920.6 are cited where appropriate.

The Air District has not explained the necessity to adopt the proposed amendments

Comment: Commenters state that the Air District has not fully explained the necessity of amending Rule 6-5. Commenters state that while the Air District asserts that the proposed amendments are "necessary" because the Bay Area is not in attainment for certain PM standards, the emissions reductions achieved by Rule 6-5 represent less than 1% of current PM emissions in the Bay Area and would not bring the area into attainment with relevant standards. Commenters state that the Air District does not explain why it must regulate PM emissions from Bay Area refinery FCCUs, or why it must mandate WGSs as the control equipment to meet emissions requirements rather than other alternatives considered by the District that are cost-effective, achieved in practice, and significantly reduce FCCU emissions. Commenters state that AB 617 does require BARCT planning in general, but does not mandate that the District impose a specific form of BARCT on a particular emissions source, and does not necessitate any amendment to Rule 6-5.

Chevron, PBF (JF), WSPA

Response: Health & Safety Code Section 40727(a) requires that air district adoption of a rule must be supported by certain findings, among them a finding of "necessity" for the rule. "Necessity" is defined in Section 40727(b) to mean that "a need exists for the regulation, or for its amendment or repeal, as demonstrated by the record of the rulemaking authority." The meaning of "necessity" in Section 40727(a) is further illuminated by Health & Safety Code Section 40001(c) which provides that "prior to adopting any rule or regulation to reduce criteria pollutants, a district shall determine that there is a problem that the proposed rule or regulation will alleviate and that the rule or regulation will promote attainment or maintenance of state or federal ambient air quality standards."

These statutory provisions do not require a showing that a proposed rule will, by itself, bring about compliance with ambient air quality standards. Nor do these provisions require a comparison of a proposed rule with other rules that may be possible to adopt. Contrary to what the comments imply, the finding of "necessity" need not be based on a showing that proposed rule is the only available option for reducing emissions, or even that it is the best available option. Moreover, a finding of "necessity" may be supported even where ambient air quality standards have been achieved if the rule is an appropriate measure to help maintain that status. Read together, Sections 40727 and 40001 clarify that the "necessity" finding is a demonstration based on the rulemaking record that a proposed rule will achieve progress towards attainment or maintenance of federal or state ambient air quality standards.

The Air District does not assert that AB 617 is related to the finding of "necessity" required by Section 40727(a). The Air District's position is that a "necessity" finding for the proposed amendments could be supported even if the amendments did not also implement AB 617.

The Air District has not met the clarity requirements to adopt the proposed amendments

<u>Comment</u>: Commenters stated that the Air District does not make an adequate demonstration of the Health and Safety Code requirements for "clarity".

PBF (JF), WSPA

<u>Response</u>: As discussed in the Staff Report, the California Health and Safety Code Section 40727(b)(3) states that "'Clarity' means that the regulation is written or displayed so that its meaning can be easily understood by the persons directly affected by it."

The proposed amendments to Rule 6-5 are written so that its meaning can be easily understood by the persons directly affected by them, and further details in the Staff Report clarify the proposals, delineate the affected industry, compliance options, and administrative requirements for the industries subject to this rule. The Air District has responded to comments indicating a perceived lack of clarity regarding specific rule language.

The Air District has not met the consistency requirements to adopt the proposed amendments

<u>Comment</u>: Commenters stated that the Air District does not make an adequate demonstration of the Health and Safety Code requirements for "consistency". Commenters stated that proposed amendments are not consistent with federal regulations due to differences in the definition of "condensable particulate matter" and methods to measure filterable PM.

Chevron, PBF (JF), WSPA

Response: Comments regarding the consistency of these definitions and methods are addressed in the responses to comments in the "Testing Requirements" section.

The Air District has not met the non-duplication requirements to adopt the proposed amendments

Comment: Commenters stated that the Air District does not make an adequate demonstration of the Health and Safety Code requirements for "nonduplication". Commenters stated that the Air District must make a finding that the proposed amendments are not a duplication of existing requirements, and the new monthly reporting requirements would be duplicative with existing Regulation 1-522.8. Commenters stated that the source test reporting requirement is redundant with Title V permit conditions for the refineries that already require notification prior to testing and are duplicative of current state and federal law.

Chevron, PBF (JF), WSPA

Response: Comments regarding the duplication of reporting requirements are addressed in the responses to comments in the "Testing Requirements" section.

The Air District has not met the reference requirements to adopt the proposed amendments

Comment: One commenter stated that the Air District does not make an adequate demonstration of the Health and Safety Code requirements for "reference". The commenter states that the "reference" discussion in the Staff Report faces the same problems as the Staff Report's "authority" discussion by failing to address BARCT requirements arising from AB 617.

PBF (JF), WSPA

Response: As discussed in the Staff Report, the California Health and Safety Code Section 40727(b)(6) states that "'Reference' means the statute, court decision, or other provision of law that the district implements, interprets, or makes specific by adopting, amending, or repealing a regulation." By adopting the proposed amendments to Rule 6-5, the Air District Board of Directors will be implementing, interpreting or making specific the provisions of California Health and Safety Code Sections 40000, 40001, 40702 and 40727. Additional statutory provisions or other sources of authority are referenced where appropriate throughout the Staff Report and these responses to comments.

Comments regarding authority are addressed in the responses to comments elsewhere in this "Statutory Findings" section.

Testing requirements

EPA Method 202 used by the Air District overestimates PM

Comment: Commenters stated that the test method used by the Air District results in artifacts that overestimate condensable PM. Commenters stated that EPA Method 202 is seriously flawed because it includes PM associated with condensation of the water vapor from the gases.

Commenters state that EPA Method 202 requires that stack gas be cooled with no dilution, which condenses water in the stack gas causing absorption of ammonia, sulfate, and nitrate species to form salts that are inappropriately assessed as PM emissions. Commenters state that source test results at the FCCUs show that condensable PM samples contain significant amounts of sulfate and ammonium. Commenters stated that because the sulfuric acid is captured as filterable PM, the sulfate is a result of the sulfur dioxide water artifact.

Commenters state that the US EPA has revised EPA Method 202 multiple times to address artifacts and has not yet finalized its 2017 proposed revisions. Commenters state that the US EPA's proposed revisions to EPA Method 202 identify that limitations of the method include that "High moisture in the sampled gas stream can result in the accumulation of SO2 in the collected moisture resulting in a positive bias for CPM measurements. As the moisture accumulates in the sample impingers, the method performs similarly to the original version of Method 202 where SO2 in the effluent could react in the condensed moisture and form sulfuric acid that may be counted erroneously as CPM."

Chevron, PBF (BN2), WSPA

Response: In 2010 the EPA adopted revisions to EPA Method 202 to include dry impingement, and other changes, which addressed sulfur dioxide artifact formation in the sample collection system. The prior version of the method bubbled the sampled stack gas through water within the impingers where sulfur dioxide could dissolve and later form sulfuric acid that would add to the condensable particulate mass. As mentioned in the comment, the dry impingement method does condense water vapor from the sampled stack gas. However, the dry impingement method does not allow adequate mixing and residence time for enough sulfur dioxide to dissolve into the condensed water to form any significant amounts of sulfate (75 FR 80118; EPA, 2016). Prevention of sulfate artifacts is further addressed by the required post-test nitrogen purge which will strip sulfur dioxide from the condensate before it has had time to form sulfate. This further reduces any potential bias attributed to sulfur dioxide.

The formation of condensable particulate matter from sulfate, nitrate, ammonia, and their associated salts in the EPA Method 202 dry impingement system has not been shown to be solely associated with water vapor condensation interactions. Further, it has not been shown that these chemical species are being formed as an artifact from precursors due to water-based reactions in the vapor phase or during condensation. Although it is possible to infer that water condensation could aid to some extent in the capture of these species, it cannot be inferred that these species are being created from artifact precursors in that process. Air District and EPA definitions of condensable particulate matter include contributions from these chemical species. Any of these chemical species that exist as filterable particulate matter at stack conditions or condense upon cooling to a defined temperature range of 68ºF to 85ºF need to be quantified and included in a measurement of total primary particulate emissions, including PM10 and PM2.5.These chemical species are included in measures of ambient PM10 and PM2.5 and when preparing emission inventories, so should be correctly attributed as primary contributions directly from emission sources rather than inappropriately attributed to secondary precursors.

While sulfuric acid may appear as filterable PM at certain stack gas conditions the application of appropriate source test methodology can minimize or eliminate this effect and properly partition this form of sulfate into the condensable particulate fraction rather than the filterable fraction. Any sulfate, nitrate, ammonia or associated salts present at the point of sampling are considered condensable particulate matter. Only sulfates formed directly from sulfur dioxide and condensed water interaction in the EPA Method 202 sampling train would be considered sulfate artifact which has already been addressed by method improvements and EPA guidance.

Although the US EPA's 2017 proposed revisions to EPA Method 202 have not yet been adopted, the EPA has already addressed issues related to remaining sulfuric acid artifact formation due to sulfur dioxide in their published EPA Method 202 Best Practices Handbook (EPA, 2016). Prior to water condensation occurring to the extent that the stack gas is bubbling through the collected condensate the test run should be paused; the collected condensate should be recovered; and then the test run can be resumed. The condensate should be purged with Ultra High Purity Nitrogen as soon as possible and included with the total condensate catch for analysis.

Federal Register, Vol. 75, Page 80118. (75 FR 80118) December, 2010.
United States Environmental Protection Agency (EPA). 2016. EPA Method 202 Best Practices Handbook. https://www.epa.gov/emc/method-202-condensable-particulate-matter. March.

Other measurements methods such as OTM-37 are more appropriate

Comment: A number of comments focused on the relative merits of EPA Method 202, which is the source of much of the data underlying the proposed emission limits, and Method OTM-37, which was judged by the Air District to be a less reliable source of data regarding particulate emissions from FCCUs. Commenters state that dilution sampling tests using Method OTM-37 conducted on Bay Area refinery FCCUs have consistently shown significantly lower PM emissions than methods used by the Air District. Commenters state that measurement method OTM-37 more properly simulates the physical behavior of the cooling stack gas by cooling the mixture with dilution air, and information should be provided on these other test methods being studied. Commenters state that the US EPA is currently in the process of doing side-by-side comparisons of Method OTM-37 and the methods that the Air District has used, specifically in regard to their application at sources with sulfur dioxide and ammonia emissions like FCCUs. Commenters stated that dilution sampling methods were evaluated extensively in the early 2000s for turbines and external combustion sources, and the US EPA and multiple other countries have accepted the results of those tests. Commenters state that the Air District has allowed the use of such dilution test methods to demonstrate permit compliance in a Major Facility Review Permit issued to Russell City Energy Company, LLC in Hayward, CA in September 2019, and the proposed amendments should allow use of OTM-37.

Chevron, PBF (BN2), PBF (JF), WSPA

Response: The Air District disagrees with the commenters' assertion that method OTM-37 provides a more representative measurement of condensable particulate matter. OTM-37 has not been adequately evaluated by the US EPA, nor has it been proven in practice, and there is no evidence that cooling with ambient air provides a more representative measurement of condensable particulate matter than cooling without dilution. There are many physical, chemical, temporal and phase change interactions occurring both at the stack exit and within the sampling systems that need to be considered. EPA Method 202 is the reference test method for quantification of condensable particulate matter, meaning it is the only method that has been thoroughly evaluated and accepted by the US EPA as valid. There are some indications from the limited data available that use of OTM-37 reports significantly lower condensable particulate matter as compared with EPA Method 202. The discrepancy in results between the two methods needs to be adequately explained before OTM-037 can be considered for regulatory use.

Other Test Methods (OTM) are methods that have been submitted to the US EPA for consideration but have not been subjected to the rigorous evaluation and assessment needed to be accepted as promulgated methods or approved alternatives. OTMs are posted on the US EPA website because they may have some efficacy or usefulness in information gathering efforts, but they are not intended to be used for regulatory determinations except in cases where no other viable alternative exists. EPA Method 202 has undergone the level of evaluation necessary to become the promulgated reference method and is the current basis for how primary condensable particulate matter is defined.

Following a delay due to COVID-19 remote work requirements, US EPA staff have indicated that they plan to resume research work intended to evaluate the efficacy of OTM-37 and how the data generated compares with EPA Method 202. That work should also explore the reasons why OTM-37 results in lower condensable particulate matter, including physical, chemical, temporal and phase interactions that occur within the sampling system. US EPA also indicated in an April 2021 meeting that it will be at least two years before any results will be available for regulatory review and evaluation. It will take some time following that until a determination of equivalency or non-equivalency can be made. Until that process is completed, and a determination is released by the US EPA, the Air District will not accept results generated using OTM-37 for use in regulatory or policy determinations.

Although permit conditions for some facilities permitted by the Air District, including the Russell Energy Center, allow the facility to "propose" the use of dilution tunnel methods to quantify condensable particulate matter, the Air District has never approved the actual use of dilution tunnel methods and to staff's knowledge these methods, including OTM-37, have never been performed in the Air District for compliance or regulatory determinations. The Air District only accepts EPA Method 202 for quantification of condensable particulate matter and will not approve the use of dilution methods until the US EPA publishes a determination of their efficacy or officially grants approval as a promulgated or alternative method.

The proposed use of EPA Method 201A is not feasible when water droplets are present downstream of a wet gas scrubber

Comment: Commenters state that EPA Method 201A is inappropriate for filterable PM measurement in wet stacks where water droplets are present, such as downstream of a wet gas scrubber. Commenters state that EPA Method 201A states "you cannot run this method to measure emissions in which water droplets are present." Commenters state that US EPA has not promulgated a method for measuring the PM10 size fraction in exhaust streams where water droplets are present. Commenters state that it is possible to measure filterable total PM downstream of wet gas scrubbers using a different method (such as EPA Methods 5, 5B, 5F, 5I, or the modified SCAQMD Method 5.2 that is used for compliance with the SCAQMD filterable

PM limit for FCCUs), but that measurement is of total PM, not PM10, which effectively means the proposed limit applied to total PM, not total PM10.

One commenter suggested that EPA Method 5 should be added as an alternative test method for wet gas scrubbers, and the rule provide for alternative methods to be used if approved in writing by the APCO.

Chevron, Valero, WSPA

Response: The proposed amendments require EPA Method 201A to be used for testing and compliance determination requirements, but also include provisions to allow for other PM emission monitoring methods to be used with the written approval of the APCO per proposed Section 6-5-503.2. Considerations for acceptable monitoring methods include known method limitations and appropriate alternatives for specific testing conditions; for example, EPA Method 201A acknowledges the limitations of using this method to measure emissions in which water droplets are present, as the size separation of the water droplets may not be representative of the dry particle size emitted. For these emissions, EPA Method 201A recommends using EPA Method 5. The use of these accepted alternative monitoring methods could be considered for approval by the APCO on a case-by-case basis, as described in proposed Section 6-5-503.2.

Testing frequency should be reduced

Comment: Commenters stated that facilities should be allowed to decrease testing frequency from quarterly to annually if test results are consistently well below the proposed limit or if certain objective criteria are met. Commenters stated that at least two refineries are currently required to source test annually for PM, and results over the last five years from this testing have demonstrated very low variability. Commenters stated that a four-time increase in testing frequency is not supported by the source testing results.

Valero, WSPA

Response: The proposed amendments include provisions for the use of alternative emission monitoring systems for PM approved in writing by the APCO. This provision is intended to provide flexibility to affected facilities in meeting the monitoring requirements using other appropriate methods and techniques as approved in writing by the APCO. Alternative monitoring systems and techniques, including the use of different testing schedules, combinations of source testing, development of correlation equations, parametric monitoring, and monitoring of other process or emission parameters, may be considered, provided that these systems and techniques can appropriately provide equivalent information and sufficient data to evaluate compliance with applicable limits.

These are examples of some of the potential alternative systems and techniques that may be considered for approval, but approval of any alternative PM monitoring system by the APCO would require a thorough and robust technical review by Air District staff.

Opacity monitoring under high moisture conditions

Comment: Commenters state that the amended regulation should provide for compliance with the opacity limit to be demonstrated by parametric monitoring approved by the APCO. Commenters state that Regulation 1-520 can be read to suggest that continuous opacity monitors (COMS) must be installed to determine opacity from the catalyst regenerators of fluid catalytic crackers. Commenters state that while COMS are suitable for determining opacity under dry conditions, the COMS optical technology will not function correctly in a wet stack because of the high moisture content. Commenters request that the draft rule language be amended to address this engineering dilemma by allowing parametric monitoring approved by the APCO. Commenters state that the Air District's current FCCU monitoring requirements for continuous opacity monitoring systems are inconsistent with the requirement for a wet gas scrubber because droplets in the WGS exhaust invalidate the COMS measurement.

Valero, WSPA

Response: The proposed amendments do not include any proposed changes to the currently adopted opacity monitoring requirements in Regulation 1 Section 1-520, and the requested changes are beyond the scope of the proposed amendments.

Definitions of condensable particulate matter are not consistent with other regulations

Comment: Commenters state that the Air District's proposed definition of condensable particulate matter is inconsistent with federal regulations. Commenters state that the proposed definition of "condensable particulate matter" is unnecessarily different from the definition of that same term in federal regulations, including the regulatory section where the compliance test method is located, and the final regulation needs to be in harmony with the federal regulations and have the same definition of the term "condensable particulate matter" pursuant to H&SC 40727(b)(4). Commenters state that the proposed rule cites to the EPA Test Method 202, but fails to use the same definition as is included in federal regulation 40 CFR 51.50 and 40 CFR 51 Appendix M, EPA Method 202, Section 3.1.

Chevron, WSPA

Response: The EPA definition of "PM10 emissions" can be found in 40 CFR 51.100(rr), as follows: *40 CFR 51.100(rr) PM10 emissions means finely divided solid or liquid material, with an aerodynamic diameter less than or equal to a nominal 10 micrometers emitted to the ambient air as measured by an applicable reference method, or an equivalent or alternative method, specified in this chapter or by a test method specified in an approved State implementation plan.* Further, 40 CFR Part 51.165(a)(1)(xxxvii)(D) states: *"PM2.5 emissions and PM10 emissions shall include gaseous emissions from a source or activity which condense to form particulate matter at ambient temperatures."*

The approved, and promulgated, EPA reference method for determination of condensable particulate matter emissions is EPA Method 202. Equivalent or alternative test methods have not been approved in the federal regulations or in California's State implementation plan. The commentor referenced language from H&SC 40727(b)(4) reads as follows: *"Consistency"* *means that the regulation is in harmony with, and not in conflict with or contradictory to, existing statutes, court decisions, or state or federal regulations.*

The Air District finds the adopted definition in Regulation 6 Section 206.6 and proposed Rule 6-5 Section 6-5-203, as provided below, to be consistent with the federal definitions:

Regulation 6 206.6 Condensable PM: Liquid droplets that coalesce, or gaseous emissions that condense to form liquid or solid particles. These liquid and/or solid particles are identified using EPA Test Method 202. If necessary, alternate approved test methods may be used as described in Regulation 2-1-603.

Draft Regulation 6-5-203 Condensable Particulate Matter: Liquid droplets that coalesce, or gaseous emissions that condense to form liquid or solid particles. These liquid and/or solid particles are identified as condensable organic or condensable inorganic particulate matter using EPA Test Method 202.

Methods for measuring filterable PM are not consistent with other regulations

Comment: Commenters state that the proposed Rule requires a different method to measure filterable PM than the federal requirements in NSPS Subpart J. Commenters state that the Air District is proposing EPA Method 201A, which requires that the temperature of the probe and filter box be 250 ± 25°F, but Subpart J requires the use of EPA Methods 5B and 5F, which require a probe and filter box temperature of 320 ± 25°F. Commenters state that the affected refineries will need to use two methods to measure the same pollutant and the proposed amendments are not consistent with federal regulations.

Chevron, WSPA

Response: The proposed use of EPA Method 201A is for the measurement of filterable PM10, while the requirements to use EPA Methods 5B and 5F in NSPS Subpart J are intended to measure filterable PM. There is therefore no inconsistency with federal regulations.

Compliance testing must be conducted by the Air District

Comment: Commenters state that refineries must not be allowed to self-monitor and self-report their own compliance. Commenters stated that source tests for compliance must be conducted by the agency or contractors retained by the agency and recouped by fees.

350 Bay Area, Community Energy reSource

Response: As the US EPA's delegated agency for the region, the Air District is tasked with oversight of source testing conducted within the geographical boundaries of its authority. Although Air District staff and management greatly appreciate and value the unique in-house source testing capabilities that the agency possesses, and staff routinely conduct source testing throughout the Bay Area to improve emission inventories, establish emission factors, audit facility compliance, perform special projects and collect needed emissions data for policy development, the Clean Air Act firmly establishes that the burden of maintaining and showing compliance with emission standards rests on the owners and operators of regulated facilities.

This burden to maintain and confirm compliance extends to all source testing and monitoring activities and requires facilities to directly bear the costs to perform field sampling and report the results in accordance with regulatory requirements and standards. The specific test requirements and standards are codified in Air District, State and Federal regulations, permit conditions, the Air District Manual of Procedures and guidance documents.

Owners and operators are required to notify the Air District of all scheduled source tests, submit test plans for review when necessary and submit final reports, documenting the results and test conditions during the testing performed, for review and approval by highly trained and qualified Air District technical staff. These test reports are reviewed in intricate detail to ensure that facility source tests conform to all reference method and Air District requirements, and confirm that the reported results are accurate, representative, and defensible. In cases where the testing is determined to be deficient, the source test results submitted are disapproved, resulting in mandatory retesting and/or recommendation for possible violation when determined appropriate. Test results documenting failures to comply with emission, or associated, limitations are referred to the Compliance & Enforcement Division for further evaluation of potential violations.

Source tests are performed by highly qualified professional staff, who are typically specialty consultants hired by the facilities, utilizing approved and promulgated reference test methods as codified in the Code of Federal Regulations, the California Health and Safety Code and Air District documents.

Continuous Emissions Monitors and source testing provide different information

Comment: One commenter stated that Continuous Emissions Monitors can measure direct emissions on a continuous basis, while source testing can provide relevant information but is only a snapshot of time.

PBF (AN)

Response: While Continuous Emissions Monitors (CEMs) and source tests both provide valuable and relevant emissions information, each technique may have unique advantages, limitations, and constraints. The feasibility and cost of CEMs were important factors in determining the appropriate monitoring method for the proposed amendments. The proposed amendments to Rule 6-5 include requirements for source testing to demonstrate compliance with the proposed limits. However, other PM monitoring systems would be considered pursuant to Section 6-5-503.2.

Delays in source testing have delayed rulemaking efforts

Comment: One commenter stated that delays in source testing have further delayed the rulemaking effort for the proposed amendments. One commenter stated that starting in 2015, the District made numerous commitments to gather current CPM data using EPA approved methodologies but failed to collect any current data until late 2020 at the PBF Martinez Refinery, and the lack of data required to develop a technically valid rule has been a known deficiency since 2015.

350 Bay Area, PBF (JF)

Response: The Air District hired a source test contractor in 2016 to perform a particulate testing engineering study at on the exhaust of CO Boiler #2 at the PBF Martinez Refinery. This testing was conducted to collect baseline particulate emission data for Rule 6-5 ammonia optimization plan projects and quantified total particulate emissions, which included both total filterable and condensable particulate matter emissions. This is the only CPM testing commitment from 2015 of which staff is currently aware. However, in the process of developing the draft rule, and making a determination, staff reviewed numerous source test reports from FCCUs equipped with both wet gas scrubbers and electrostatic precipitators.

Reporting requirements are duplicative

Comment: Commenters stated that the Air District must make a finding that the proposed amendments are not a duplication of existing requirements, and the new monthly reporting requirements under a new Section 6-5-404 is unnecessary as it would be duplicative with existing Regulation 1-522.8. Commenters stated that the source test reporting requirement is redundant with Title V permit conditions for the refineries that already require notification prior to testing and are duplicative of current state and federal law.

Chevron, WSPA

Response: The monthly reporting requirement in Regulation 1-522.8 applies to Continuous Emission Monitors. The proposed amendments allow for the use of other monitoring systems where Regulation 1-522.8 reporting requirements may not apply. Therefore, the requirements in proposed Section 6-5-404 are necessary to ensure all relevant monitoring data is reported and are not duplicative.

The proposed amendments also allow for the use of other emission monitoring systems for Total PM10 and Total PM2.5, which may include a combination of source testing and/or other monitoring methods. Therefore, the proposed reporting requirements are necessary to ensure all relevant monitoring data is reported and are not duplicative.

Supplemental Summary of Comments and Responses on the Regulatory Package for Proposed Amendments to Regulation 6, Rule 5: Particulate Emissions from Refinery Fluidized Catalytic Cracking Units

Table of Contents

List of Commenters

The following table lists the individuals and organizations from whom Air District staff received written comments after the April 30, 2021, comment deadline.

Abbreviation	Commenter / Reference
Bay Area Council	Jim Wunderman President & CEO Bay Area Council Letter, April 6, 2021
Building & Construction Trades Council	Andreas Cluver, Secretary-Treasurer, Alameda County Building & Construction Trades Council Bill Whitney, CEO, Contra Costa County Building & Construction Trades Council Danny Bernardini, Business Manager, Napa-Solano County Building & Construction Trades Council David Bini, Executive Director, Santa Clara County Building & Construction Trades Council Cherie Cabral, CEO, Marin-Sonoma County Building & Construction Trades Council James Ruigomez, Business Manager, San Mateo County Building & Construction Trades Council Manny Pinheiro, CEO, Monterey-Santa Cruz County Building & Construction Trades Council Rudy Gonzalez, Secretary-Treasurer, San Francisco County Building & Construction Trades Council Bay Area Regional Building & Construction Trades Council Letter, April 5, 2021
C. Gilbert	Chris Gilbert Resident Email, May 3, 2021
Chevron (AD)	Alan Davis Director, Richmond Refinery Chevron Products Company Letter, May 27, 2021
Chevron (MC)	Michael Carroll Latham & Watkins, LLP Letter, May 26, 2021
M. Steinberg	Mayoor Steinberg Resident Email, May 3, 2021
N. Ratto	Nicholas Ratto, Pharm. D. Resident Email, May 24, 2021
NCCRC	Curtis Kelly Assistant Executive Secretary-Treasurer Northern California Carpenters Regional Council Letter, April 6, 2021

Abbreviation	Commenter / Reference
P. Haan	Patrice Haan Resident Email, May 3, 2021
PBF Energy	Timothy Paul Davis Western Region President PBF Energy Letter, May 18, 2021
V. Van Kuran	Virginia Van Kuran Resident Email, May 3, 2021

General Comments

Support for proposed amendments

Comment: Several commenters expressed support for proposed amendments to achieve associated health benefits.

C. Gilbert, N. Ratto, M. Steinberg, P. Haan, San Pablo, V. Van Kuran

Response: The Air District provided a response to similar comments in the Summary of Comments and Responses dated May 24, 2021 (page 6).

Support for consideration of other options

Comment: Several commenters expressed support for other control options instead of the proposed amendments. Several commenters stated that a less stringent PM limit of 0.020 gr/dscf, with flexibility as to how this would be met by each facility, would allow refining operations to remain economically feasible and still achieve substantial emission reductions.

Bay Area Council, Building & Construction Trades Council, Chevron (AD), NCCRC, PBF Energy

Response: The Air District provided a response to similar comments in the Summary of Comments and Responses dated May 24, 2021 (page 7).

Cost-Effectiveness and Incremental Cost-Effectiveness

Cost-effectiveness and incremental cost-effectiveness have not been properly considered and are not supported

Comment: Commenters stated that the Air District has not conducted the required cost-effectiveness analysis in a robust, transparent, or accurate way as required by California law, and the cost per ton is underestimated due to underestimated costs and overestimated emission reductions. Commenters stated that the Best Available Retrofit Control Technology is required to be cost-effective, and the proposed amendments do not meet this criterion. Commenters stated that the cost per ton of the proposed amendments is substantially higher than other adopted Air District rules.

Commenters also stated that the Air District has not considered incremental cost-effectiveness of other control options as required by the California Health and Safety Code, and has not explained how cost-effectiveness and incremental cost-effectiveness were considered in the determination of the recommended controls.

Chevron (AD), Chevron (MC), PBF Energy

Response: The Air District provided a response to similar comments in the Summary of Comments and Responses dated May 24, 2021 (page 7).

Cost Estimates

Compliance costs are underestimated

Comment: Commenters stated that cost estimates developed by staff for the proposed amendments are underestimated.

Chevron (AD), Chevron (MC), PBF Energy

Response: The Air District provided a response to similar comments in the Summary of Comments and Responses dated May 24, 2021 (page 8).

Emissions and Modeling

Estimates of emissions and reductions are not accurate

Comment: Commenters stated that FCCU and refinery emissions are overestimated.

Chevron (AD), Chevron (MC), PBF Energy

Response: The Air District provided a response to similar comments in the Summary of Comments and Responses dated May 24, 2021 (page 12).

Emissions from other refinery sources and other refineries should not be included in modeling

Comment: One commenter stated that the health effects outlined in the March 2021 Staff Report used the entirety of refinery PM emission sources, however, the proposed amendments to Rule 6-5 are intended to further control PM emissions from refinery FCCUs, which represent a fraction of total refinery PM emissions.

The commenter stated that emissions from the Marathon Martinez Refinery should not be included in the Staff Report.

Chevron (AD)

Response: The Air District provided a response to similar comments in the Summary of Comments and Responses dated May 24, 2021 (page 15).

Air quality model selection is not appropriate

Comment:
One commenter stated that the environmental consultant ERM performed PM2.5 dispersion modeling in the AERMOD model using the same modeling inputs (source emissions and stack parameters) and surface data from Chevron's onsite meteorological station, with upper air and supplemental surface data from Oakland International Airport obtained from the Air District. The commenter states that the results show that modeled ground-level concentrations resulting from FCCU emissions occur over the Bay, avoiding populated areas near the refinery, and the magnitude of these maximum concentrations are significantly less than the District's reported maximum concentration. The commenter stated that the Air District should use AERMOD for their FCCU PM dispersion modeling.

Chevron (MC)

Response: The Air District provided a response to similar comments in the Summary of Comments and Responses dated May 24, 2021 (page 17).

Meteorological data used in the modeling are not appropriate

Comment: One commenter stated that on-site meteorological data should have been used in the Air District's modeling

Chevron (MC)

Response: The Air District provided a response to similar comments in the Summary of Comments and Responses dated May 24, 2021 (page 20

Modeling results should be compared and calibrated to monitoring data

Comment: One commenter stated that ambient data does not show a statistically significant difference in ambient PM2.5 concentrations during periods in which the Chevron Refinery FCCU was shut down and not operational.

Bay Area Council

Response: The Air District provided a response to similar comments in the Summary of Comments and Responses dated May 24, 2021 (page 22).

Environmental Impacts

CEQA requirements have not been fulfilled

Comment: Commenters stated the Air District has not conducted an adequate CEQA analysis for the Proposed Amendments. One commenter stated that the Air District is relying on an inappropriate CEQA EIR and needs to prepare an EIR for this rule development. The commenter stated that there is significant new information that requires that the District conduct additional environmental review and prepare a subsequent or supplemental EIR.

The commenter stated that the proposed amendments could cause the foreseeable closure of one or more Bay Area refineries, which could lead to severe economic and social impacts. The commenter stated that while CEQA does not require a stand-alone analysis of social or economic impacts, an agency must consider economic and social consequences when they are related to a physical change in the environment. The commenter stated that if evidence suggests that the economic and social effects caused by the project ultimately could result in urban decay or deterioration, then the lead agency is obligated to assess this indirect impact.

Chevron (AD), Chevron (MC)

Response: The Air District provided a response to similar comments in the Summary of Comments and Responses dated May 24, 2021 (page 24).

The Air District has not fully analyzed and mitigated water impacts under CEQA

Comment: Commenters stated that the District has failed to fully analyze and mitigate the significant environmental impacts of multiple mandated wet gas scrubbers that would be required under the proposed amendments. Commenters stated that wet gas scrubbers would significantly increase freshwater demand in a region already constrained by water supply and in drought conditions. Commenters stated that the EIR does not address whether recycled water would be available to the facilities. One commenter also stated that the District has failed to fully analyze and mitigate the potentially significant water quality impacts of wet gas scrubbers

Bay Area Council, Chevron (AD), Chevron (MC)

Response: The Air District provided a response to similar comments in the Summary of Comments and Responses dated May 24, 2021 (page 28).

The Air District has not properly analyzed and mitigated GHG impacts under CEQA

Comment: One commenter stated that the Air District has failed to properly analyze Greenhouse Gas Emissions impacts.

Chevron (MC)

Response: The Air District provided a response to similar comments in the Summary of Comments and Responses dated May 24, 2021 (page 29).

The Air District has not properly analyzed energy impacts under CEQA

Comment: Commenters stated that the Air District did not adequately consider energy impacts in the EIR. One commenter stated that it is not evident how energy usage estimates were developed.

Chevron (AD), Chevron (MC)

Response: The Air District provided a response to similar comments in the Summary of Comments and Responses dated May 24, 2021 (page 30).

The Air District has not properly analyzed air quality impacts under CEQA

Comment: One commenter stated that the Air District has failed to fully analyze significant air quality impacts for wet gas scrubbers.

Chevron (AD)

Response: The Air District provided a response to similar comments in the Summary of Comments and Responses dated May 24, 2021 (page 31).

The Air District has not properly analyzed aesthetics impacts under CEQA

Comment: One commenter stated that the EIR fails to account for changes to aesthetics that could result from the increased visibility of the new wet gas scrubber plume.

Chevron (AD)

Response: The Air District provided a response to similar comments in the Summary of Comments and Responses dated May 24, 2021 (page 33).

Feasibility of Controls and Proposed Limits

Wet gas scrubbing controls are not technically feasible

Comment: One commenter stated that installation of a wet gas scrubber at the PBF Martinez Refinery is not technically feasible.

PBF Energy

Response: The Air District provided a response to similar comments in the Summary of Comments and Responses dated May 24, 2021 (page 33).

Proposed limits are not achievable

Comment: Commenters stated that the Air District has not demonstrated that the proposed limits are achievable or technically feasible. One commenter stated that these is no allowance for testing or process variability.

Chevron (AD), Chevron (MC)

Response: The Air District provided a response to similar comments in the Summary of Comments and Responses dated May 24, 2021 (page 34).

Health Impacts

The health benefits of the proposed amendments (Scenario B) are indistinguishable from those of a less stringent control option (Scenario A)

Comment: One commenter stated that, in terms of health benefits, it may be just as beneficial to choose the less stringent control option (Scenario A) over the proposed amendments (Scenario B). A figure ("Figure 3") was provided, in which the reported ranges of benefits attributable to mortality reductions were drawn in a manner similar to confidence intervals. A second figure ("Figure 4") was provided, in which similar depictions were rendered for four other health endpoints.

Chevron (MC)

Response: The commenter's statement misinterprets the meaning of the health benefit ranges for Scenario A and Scenario B, and compares the data in an inconsistent manner to draw an improper conclusion.

For mortality, the lower and upper bounds of the reported ranges correspond to the estimates of PM2.5 effects from two different studies—Krewski (2009) and Lepeule (2012), respectively. Both studies belong to the suite used by US EPA to inform regulatory decision-making.

- Using the estimates consistent with Krewski (2009), the baseline mortality is 5.1 deaths/year, and the calculated change in mortality (death/year) is -0.7 for Scenario A (a 13% reduction from the baseline mortality); and -1.2 for Scenario B (a 23% reduction from the baseline mortality). Using the estimate consistent with Krewski (2009), Scenario B results in a larger reduction.
- Using the estimates consistent with Lepeule (2012), the baseline mortality is 11.6 deaths/year, and the calculated change in mortality (death/year) is -1.5 for Scenario A (a 13% reduction from the baseline mortality); and -2.7 for Scenario B (a 23% reduction from the baseline mortality). Using the estimate consistent with Lepeule (2012), Scenario B results in a larger reduction.

When applying these estimates of PM2.5 health effects in a consistent manner for both Scenario A and Scenario B, Scenario B results in a larger reduction. The commenter suggests that the health benefits of Scenario A calculated using estimates from Lepeule (2012) can be compared to the health benefits of Scenario B calculated using estimates from Krewski (2009), however this is inconsistent and does not provide a meaningful comparison.

The same reasoning applies when evaluating different health endpoints, and also applies regardless of whether the baseline impact and corresponding reductions are framed in terms of (i) an entire facility, (ii) a collection of facilities, or (iii) FCCUs alone. Calculated in this consistent manner, Scenario B will always entail a larger reduction in health impacts than Scenario A.

The commenter also presented a figure ("Figure 4") in support of the claim that "for hospital admissions and emergency room visits for respiratory and cardiovascular health outcomes, the effects are […] indistinguishable from zero." For cardiovascular (CV) impacts, BenMAP was used to pool multiple studies, including some studies whose individual CIs included zero. This is standard practice, and the existence of such studies in no way contradicts the established scientific consensus that PM2.5 causes cardiovascular impacts. The Air District provided a response to related comments in the Summary of Comments and Responses dated May 24, 2021 (page 41).

The Air District modeled many other health endpoints. For a subset of those, some of the relevant confidence intervals do include zero. Figure 4 of commenter's letter highlighted Asthma ER, All-Respiratory HA, and Chronic Lung Disease HA. (It also, erroneously, included "CV Hospital Admissions" and "Asthma HA".) Although every health impact is of concern, note that the total valuation for this subset of endpoints is less than 0.04% of the total valuation of all health impacts evaluated.

As a point of clarification, the Air District's response to related comments in the Summary of Comments and Responses dated May 24, 2021 (page 39) that "[n]one of those confidence intervals include zero" refers specifically to the confidence intervals associated with the response functions (equivalently, modeled impacts) for mortality and cardiovascular endpoints. It does not refer to all modeled response functions, nor to every individual study used to construct those functions (some of which were pooled).

Socioeconomic Impact Analysis

Proposed amendments may cause significant impacts on the supply of aviation jet fuel and increase fuel imports

Comment: Commenters stated that the proposed amendments may cause significant issues for the viability of the refining industry and impacts on the supply of conventional aviation jet fuel needed for airline operations.

Commenters stated that if refineries in the Bay Area are decommissioned due to regulations, fuel will be produced and imported from other countries with less stringent safety and environmental standards.

Bay Area Council, Building & Construction Trades Council, NCCRC, PBF Energy

Response: The Air District provided a response to similar comments in the Summary of Comments and Responses dated May 24, 2021 (page 47).

Testing requirements

EPA Method 202 used by the Air District overestimates PM

Comment: Commenters stated that the test method used by the Air District results in artifacts that overestimate condensable PM.

Chevron (AD), Chevron (MC)

Response: The Air District provided a response to similar comments in the Summary of Comments and Responses dated May 24, 2021 (page 50).

Other measurements methods such as OTM-37 are more appropriate

Comment: One commenter stated that the proposed amendments should allow the use of Method OTM-37 instead of EPA Method 202. The commenter stated that a study is being conducted under a Cooperative Research and Development Agreement (CRADA) between the American Petroleum Institute (API) and the National Risk Management Research Laboratory of the USEPA to compare results of EPA Method 202 and Method OTM-37, and support understanding of the application of these methods for regulatory purposes.

Chevron (MC)

Response: The Air District provided a response to similar comments in the Summary of Comments and Responses dated May 24, 2021 (page 52).

The proposed use of EPA Method 201A is not feasible when water droplets are present downstream of a wet gas scrubber

Comment: One commenter stated that EPA Method 201A is inappropriate for filterable PM measurement in wet stacks where water droplets are present, such as downstream of a wet gas scrubber.

Chevron (AD)

Response: The Air District provided a response to similar comments in the Summary of Comments and Responses dated May 24, 2021 (page 53).

Transportation Fuels Trends, Jet Fuel Overview, Fuel Market Changes & Potential Refinery Closure Impacts

BAAQMD Board of Directors Special Meeting

Via Zoom

May 5, 2021

Gordon Schremp

Energy Assessments Division

California Energy Commission

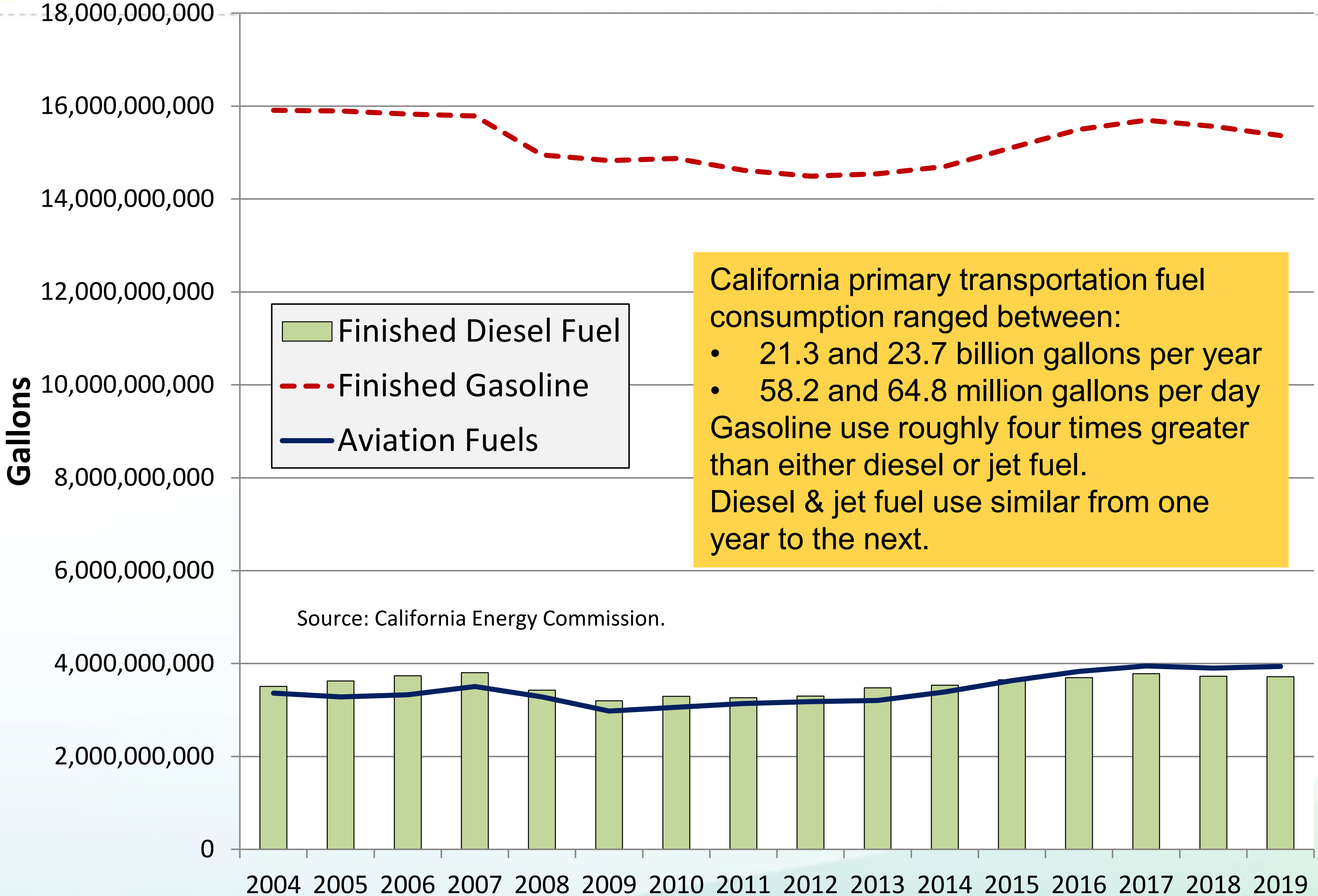
gordon.schremp@energy.ca.gov

Overview

- Transportation Fuel Demand
  - California historical & pandemic demand impacts
  - Forecast trends
- California Jet Fuel Market & Infrastructure
  - SF Bay Area airport supply
- Refinery Closures & Potential Market Impacts
  - Decisions based on changing fuel demand & types
    - Consolidation & conversions
  - Decisions based on facility operational costs
    - Premature refinery closure

Transportation Fuel Demand - California

California Primary Transportation Fuels



California primary transportation fuel consumption ranged between:

- 21.3 and 23.7 billion gallons per year
- 58.2 and 64.8 million gallons per day

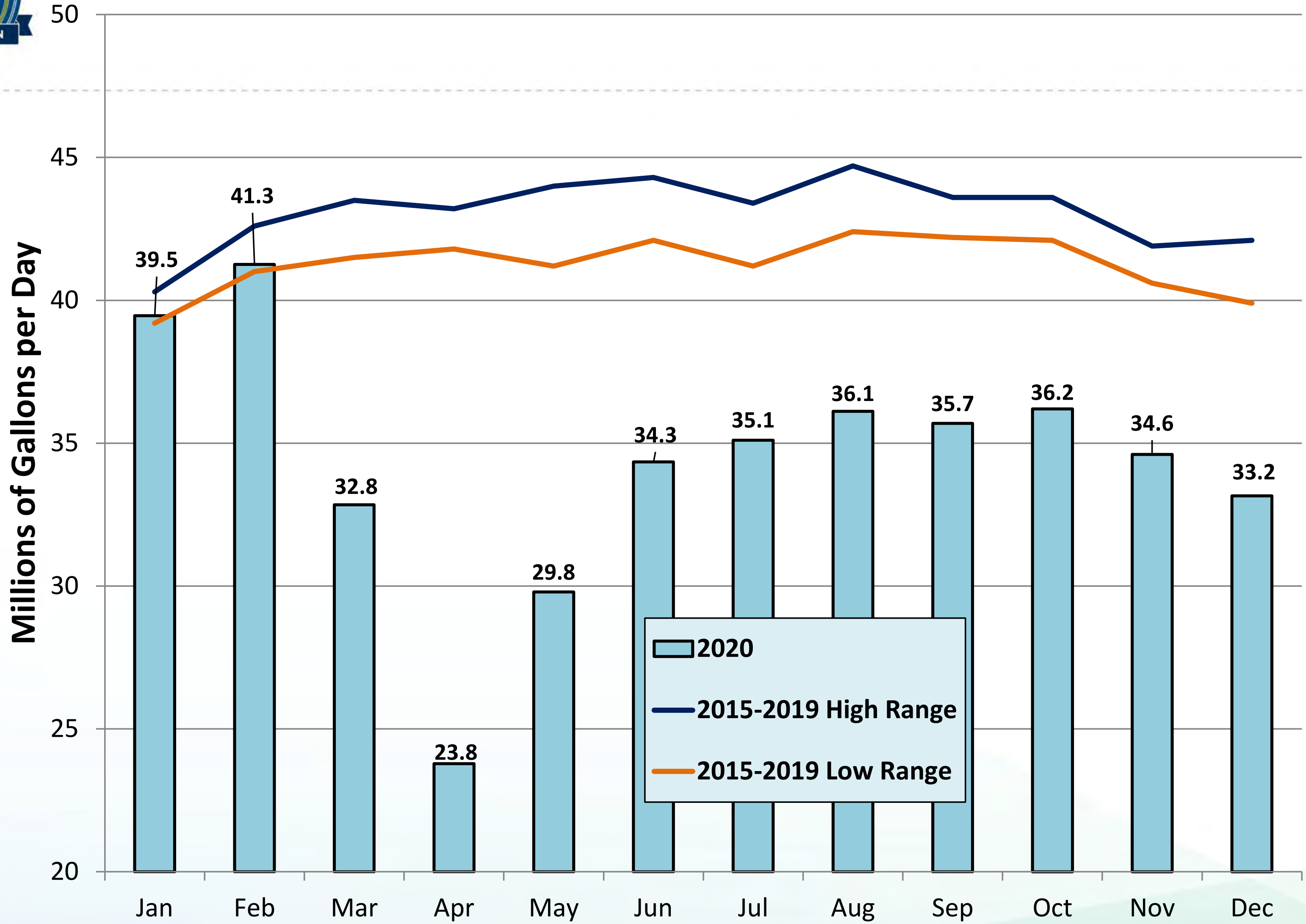
Gasoline use roughly four times greater than either diesel or jet fuel.

Diesel & jet fuel use similar from one year to the next.

Pandemic Impacts & Outlook - Gasoline

- Gasoline demand declined 18.2 percent in 2020
  - 12.58 billion gallons - lowest level since 1987
- Continues to recover
  - Still not back to pre-pandemic levels
  - Most recent estimate – still down 8.0 percent compared to April 2019
    - 4-week average demand (through week ending April 16)
  - Traffic counts still lag 2019 levels, despite much lower transit ridership
  - Varying degrees of remote work continues for private sector & government
- Forecast to continue declining over the next several years
  - Increasing percentage of ZEV light-duty vehicle sales
  - California gasoline demand peaked in 2017
  - By 2026, drop in demand (statewide) could exceed 1.0 billion gallons per year compared to current levels

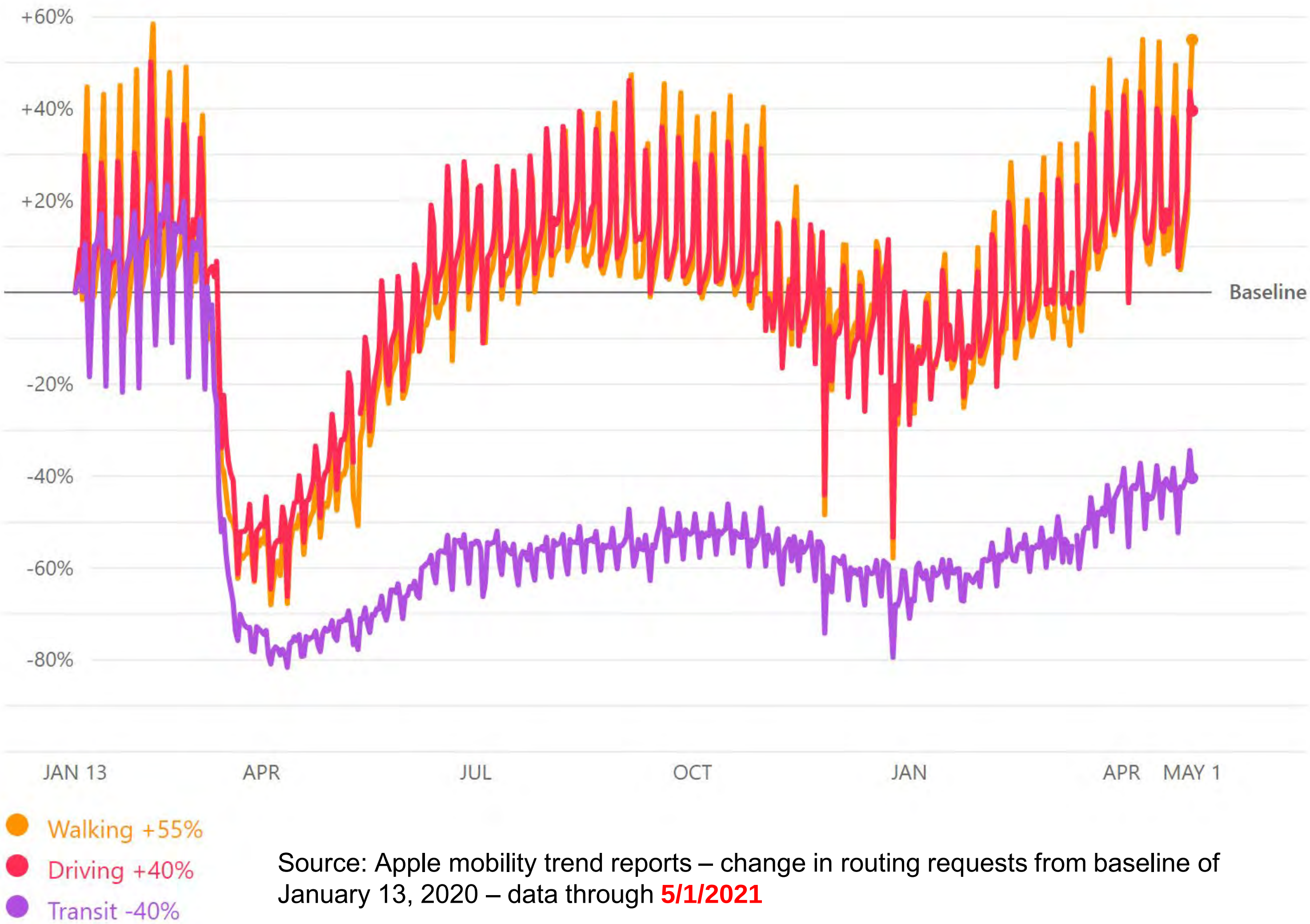
California Gasoline Demand - 2020



Data includes ethanol.

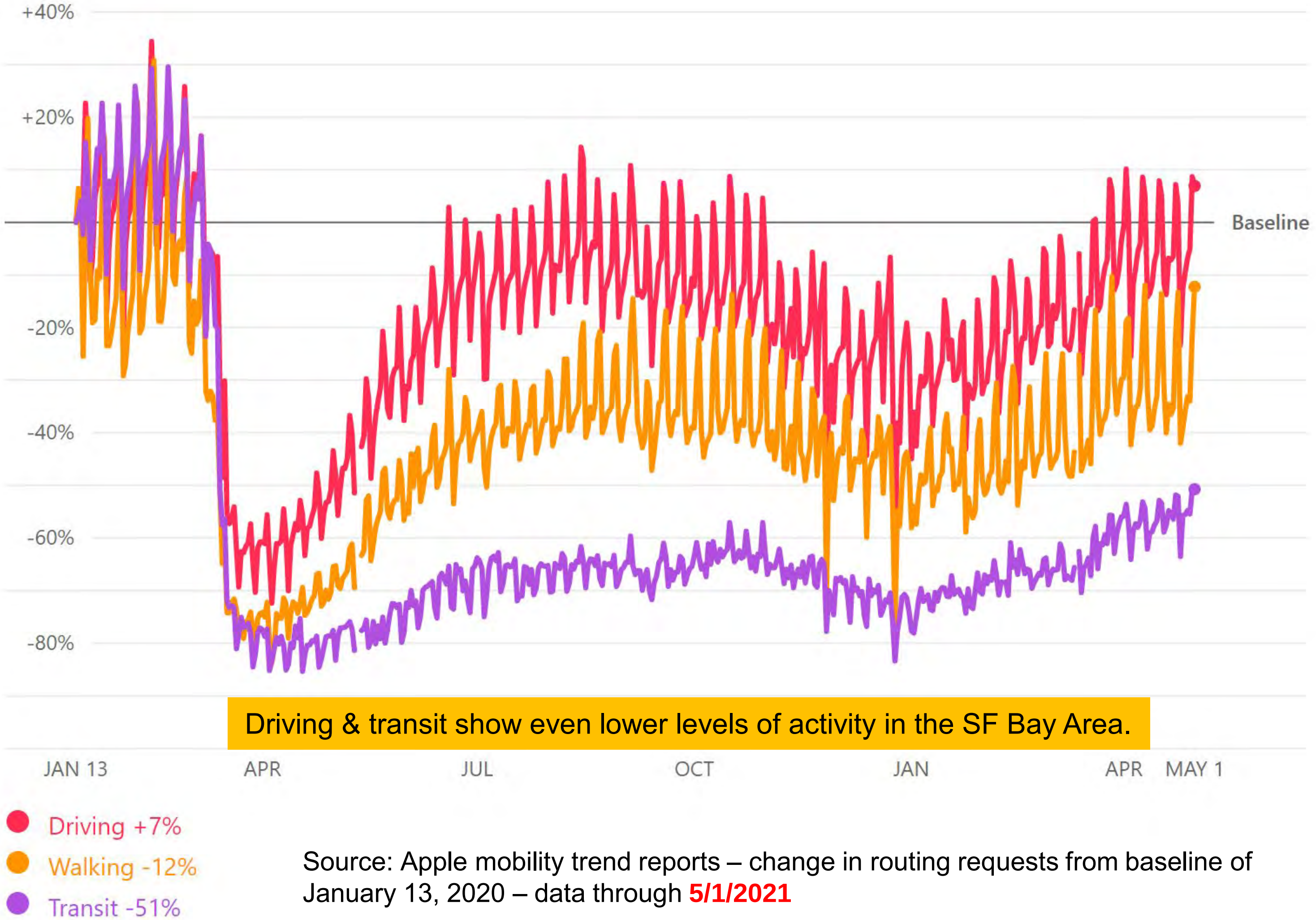
Source: California Energy Commission analysis of CDTFA data through December 2020.

Mobility Trends – California



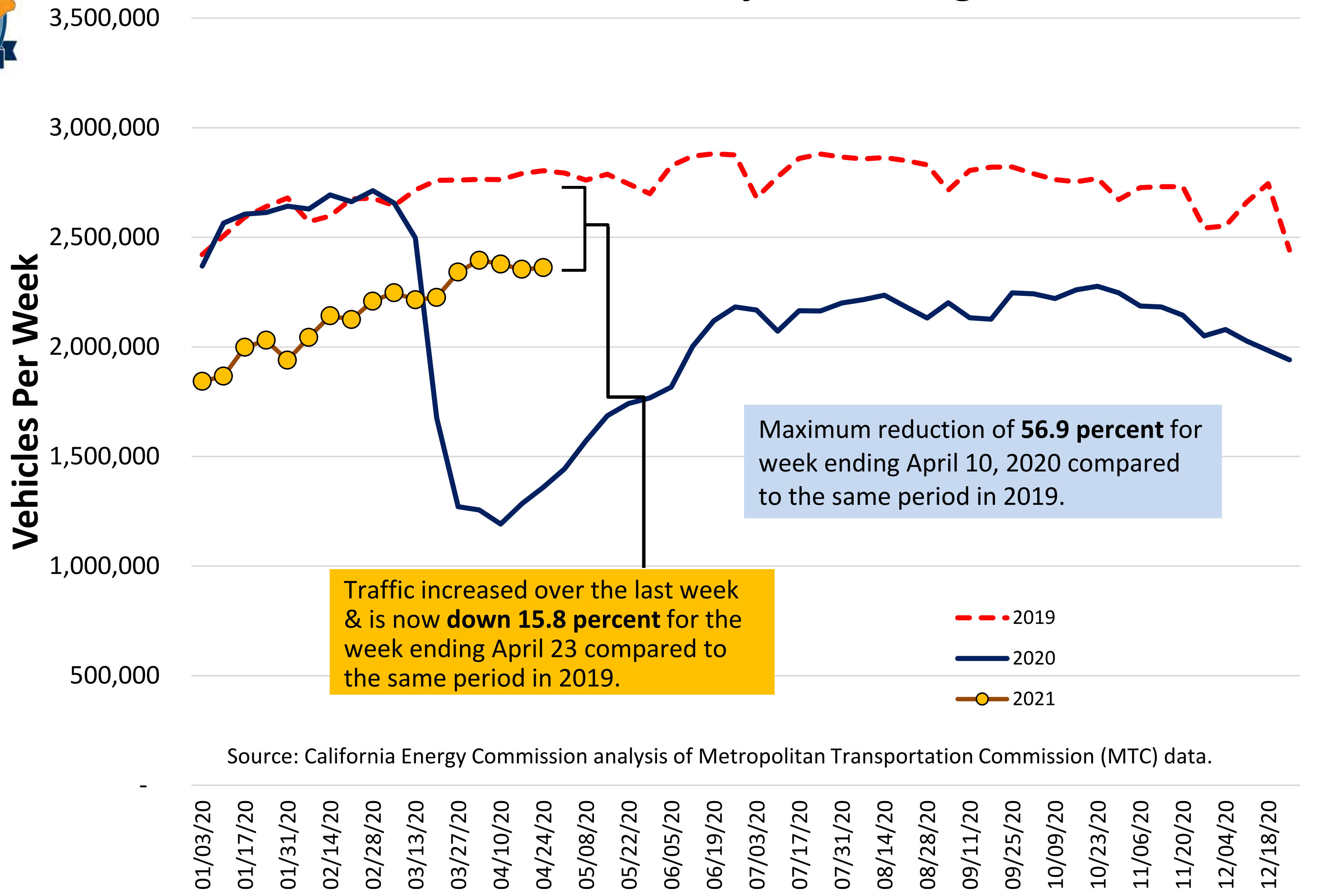
Source: Apple mobility trend reports – change in routing requests from baseline of January 13, 2020 – data through **5/1/2021**

Mobility Trends – SF Bay Area



Source: Apple mobility trend reports – change in routing requests from baseline of January 13, 2020 – data through **5/1/2021**

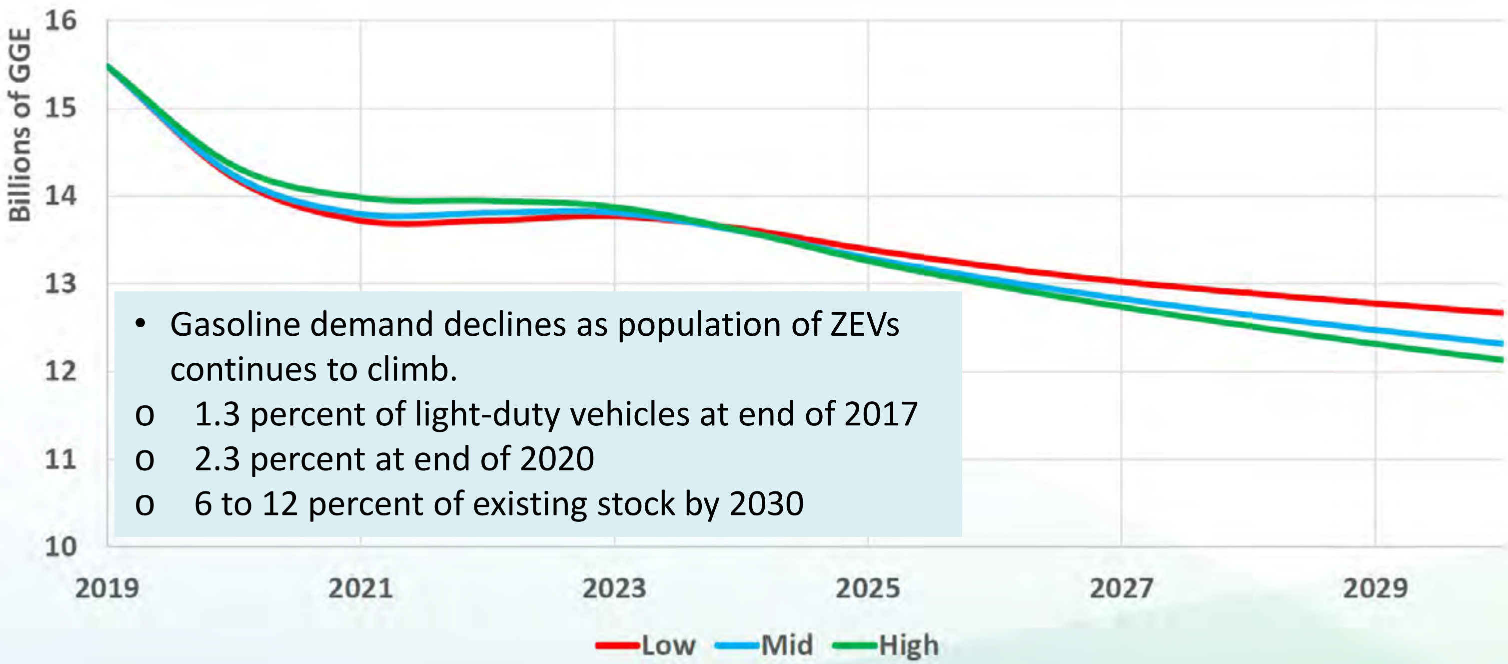
Vehicle Counts - SF Bay Area Bridges



Gasoline Demand Forecast

ZEV POPULATION		
Total Light-Duty Vehicles end of 2020		
635,602		
Battery Electric (BEV)	Plug-in Hybrid (PHEV)	Fuel Cell (FCEV)
1.289%	0.904%	0.025%
369,364	259,109	7,129

NON-ZEV POPULATION						
Total Light-Duty Vehicles end of 2020						
28,030,332						
Bio Diesel	Diesel	Flex Fuel	Gasoline	Gasoline Hybrid	Natural Gas	Propane
0.470%	1.973%	3.993%	87.286%	4.031%	0.027%	0.003%
134,834	565,532	1,144,536	25,021,380	1,155,477	7,676	897



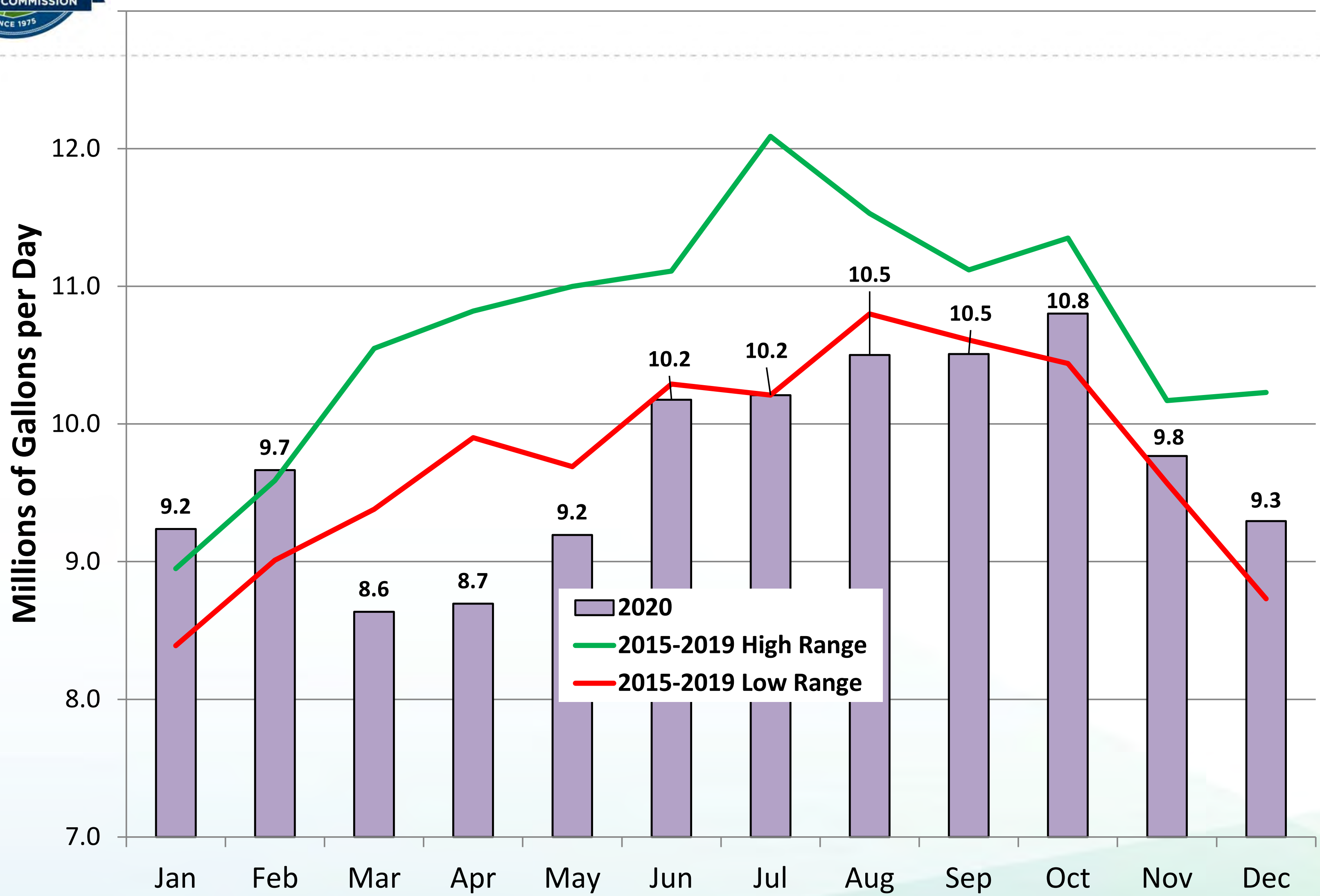
- Gasoline demand declines as population of ZEVs continues to climb.
  - 1.3 percent of light-duty vehicles at end of 2017
  - 2.3 percent at end of 2020
  - 6 to 12 percent of existing stock by 2030

Source: California Energy Commission, 2020 IEPR Workshop, December 3, 2020, Transportation Energy Demand Forecast, slide 14.

Pandemic Impacts & Outlook - Diesel

- Diesel fuel demand declined 4.3 percent in 2020
  - 3.56 billion gallons - lowest level since 2014
- Fully recovered
  - Higher than pre-pandemic levels
  - Most recent estimate – *up 12.6 percent* compared to April 2019
    - 4-week average demand (through week ending April 16)
  - Strong demand for goods movement – container imports & rail
- Forecast to continue rising over the next several years
  - However, recently adopted CARB standards for MD & HD vehicles will begin to erode those projections

California Diesel Demand - 2020



Data includes renewable diesel and biodiesel.

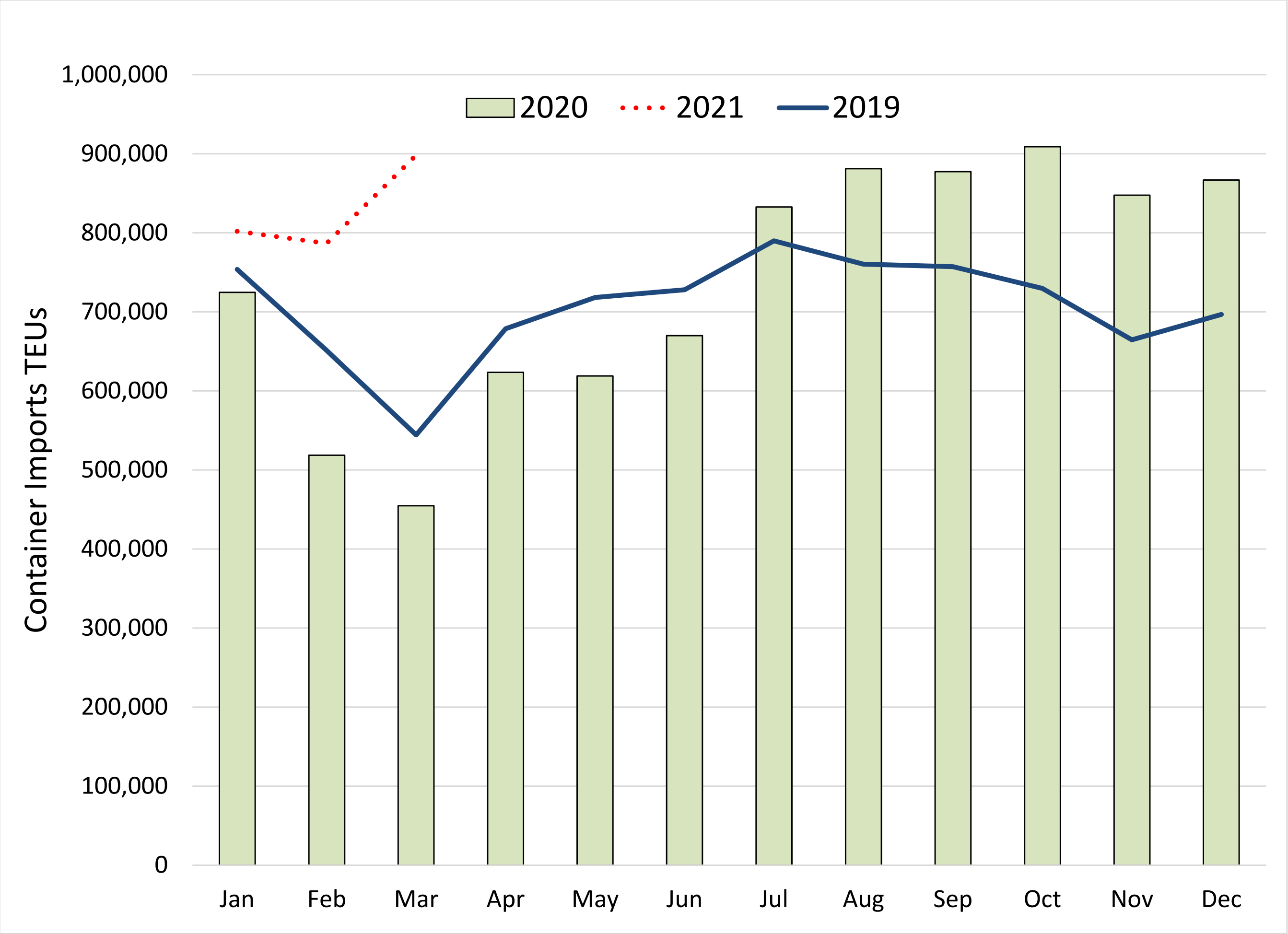
Source: California Energy Commission analysis of CDTFA data through December 2020.

Rail Activity – United States

- Intermodal rail activity is reflective of goods movement and includes railcars transporting shipping containers and truck trailers. According to AAR, more than 90 percent of the rail activity originating in California is intermodal, while nearly 80 percent of the rail activity with California as the destination was intermodal.
- Intermodal rail activity recovered last summer to pre-covid levels and has continued to improve over 2019 volumes.

2021 Y-T-D **up 4.9 percent** for intermodal rail activity versus 2019 Y-T-D.

Ports of LA & LB – Container Imports



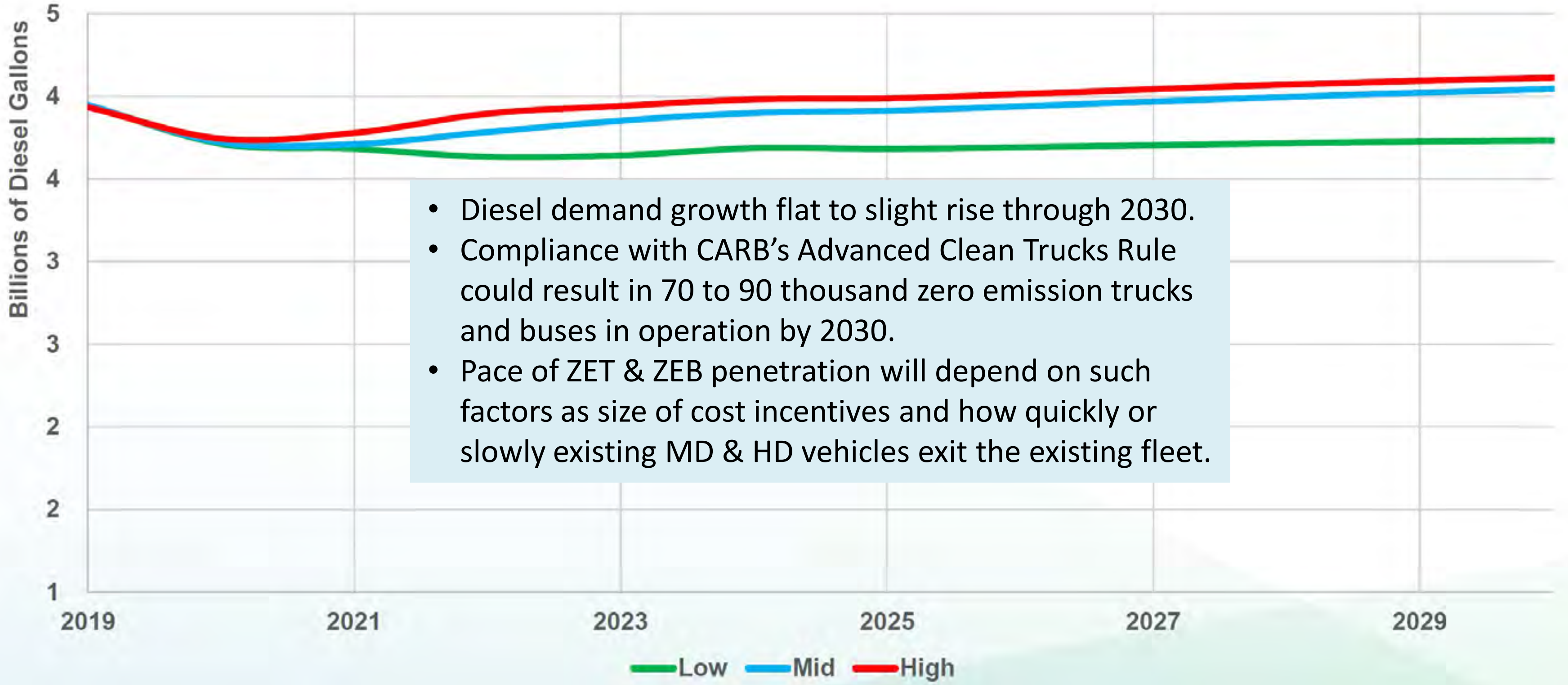
- Container imports recovery similar to rail recovery – summer of 2020
- 2021 Y-T-D through March ***up 27.6 percent*** versus same period in 2019
- 56 percent of all U.S. container imports went through the Ports of LA & LB during March 2021

Diesel Demand Forecast

Regulations designed to replace existing medium duty (MD), heavy-duty (HD), and transit buses with zero emission makes and models (electric & hydrogen) will begin to push down diesel demand during the later portions of the forecast period.

- SCAQMD regulations – refuse and transit vehicles
- CARB Advanced Clean Trucks rule – MD & HD vehicles

Projections do not illustrate the commingled trends of ***decreasing*** fossil diesel demand & ***increasing*** renewable diesel demand



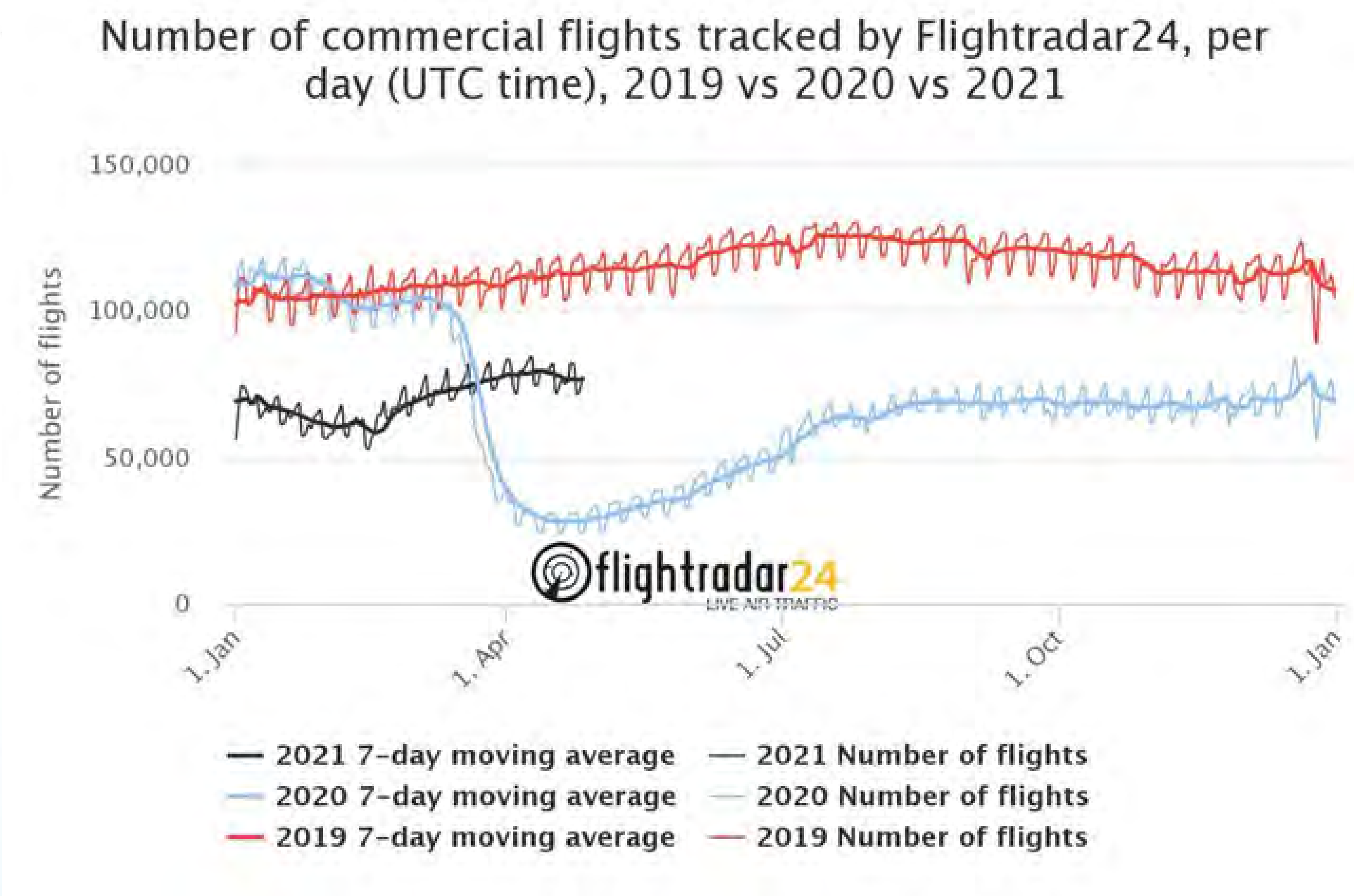
- Diesel demand growth flat to slight rise through 2030.
- Compliance with CARB's Advanced Clean Trucks Rule could result in 70 to 90 thousand zero emission trucks and buses in operation by 2030.
- Pace of ZET & ZEB penetration will depend on such factors as size of cost incentives and how quickly or slowly existing MD & HD vehicles exit the existing fleet.

Source: California Energy Commission, 2020 IEPR Workshop, December 3, 2020, Transportation Energy Demand Forecast, slide 15.

Pandemic Impacts & Outlook – Jet Fuel

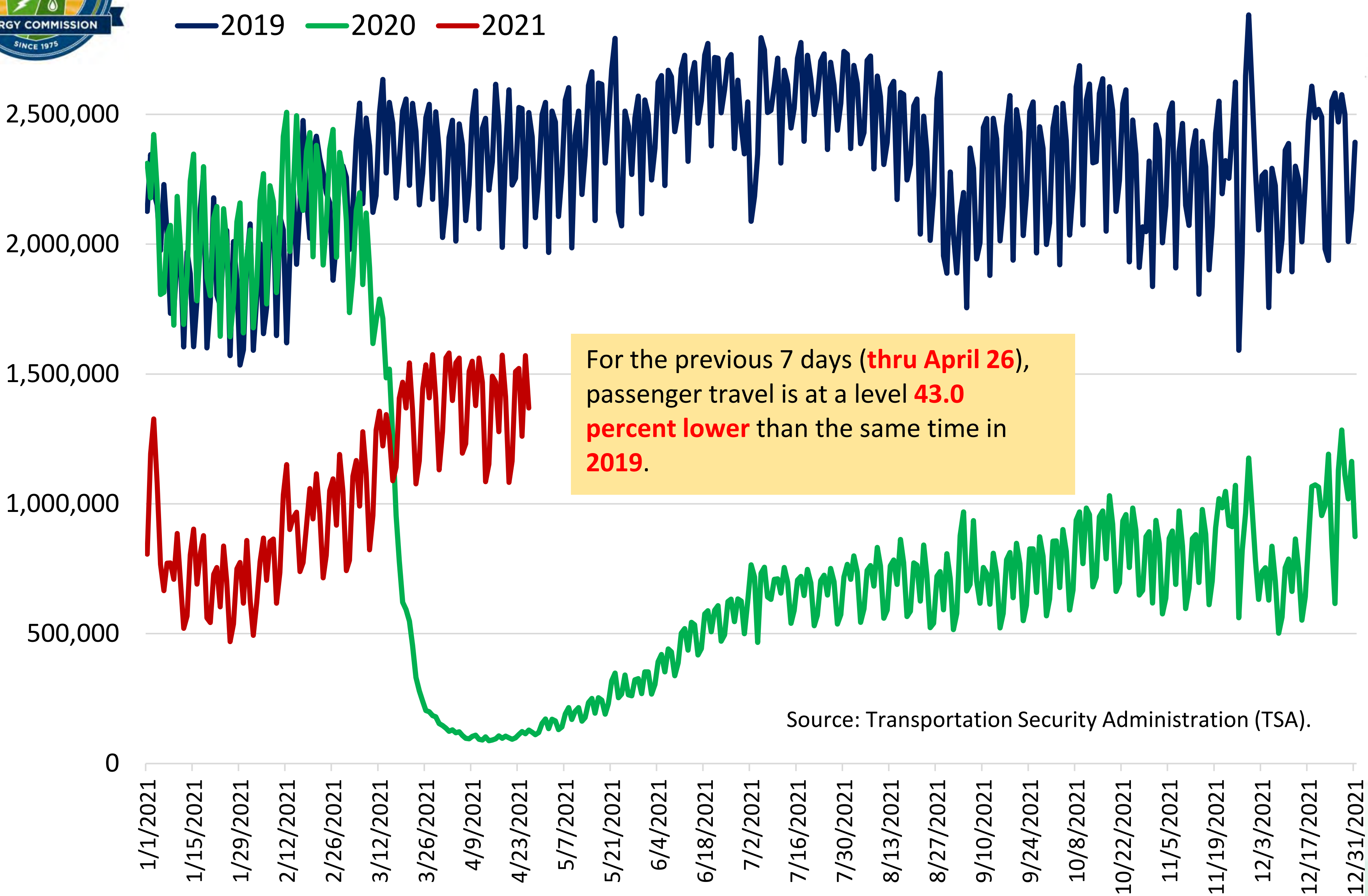
- Jet fuel demand for West Coast declined 36.1 percent in 2020 compared to 2019
  - 348 thousand barrels per day - lowest level since 1989
- Fuel type hardest hit by pandemic
  - Much lower than pre-pandemic levels
  - Most recent California estimate – *down 31.9 percent* compared to April 2019
    - 4-week average demand (through week ending April 16)
  - Decreased international travel & business flying
- Forecast to slowly continue to recover over the next couple of years
  - However, recent Covid variant spikes around the world (Brazil, India, and parts of the European Union) could continue to depress international aviation activity longer than current forecasts

Global Flight Activity Still Down



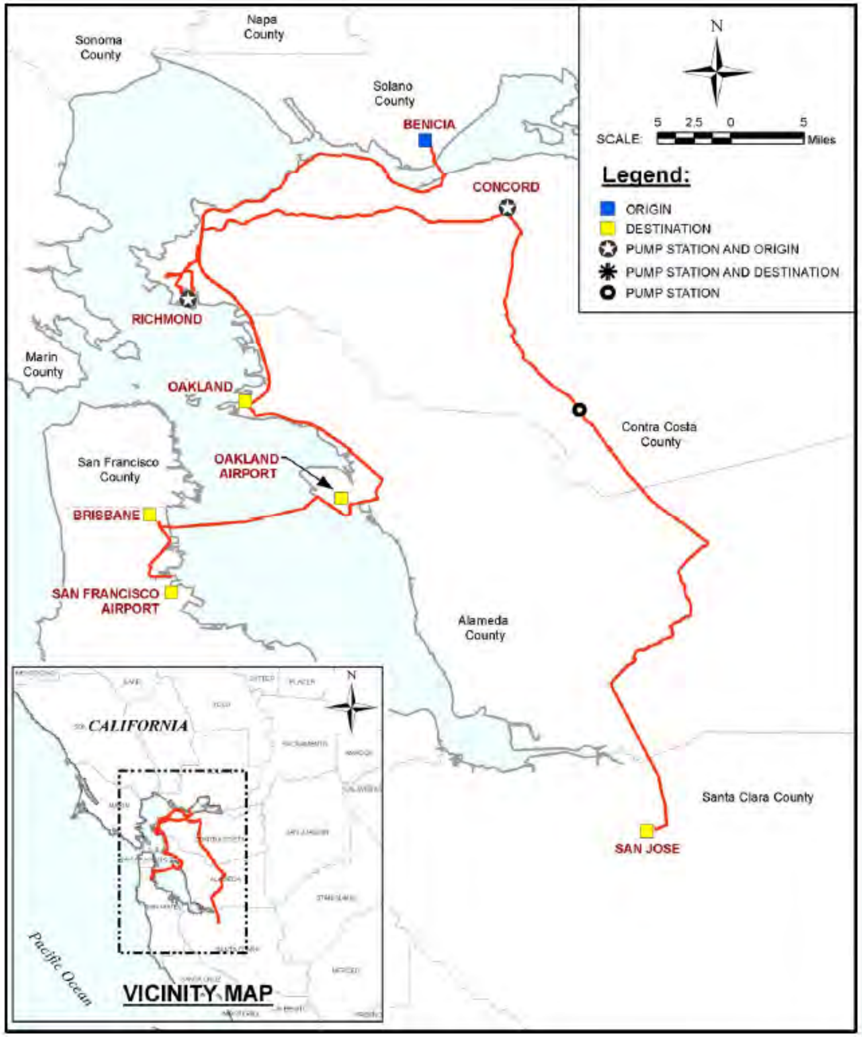
- China & Hong Kong saw earliest impacts from coronavirus
- China showing nearly complete signs of recovery
- U.S. scheduled flights down by 50.2 percent for the week ending September 14

United States Airport Passenger Counts 2019 thru 2021



Jet Fuel Overview

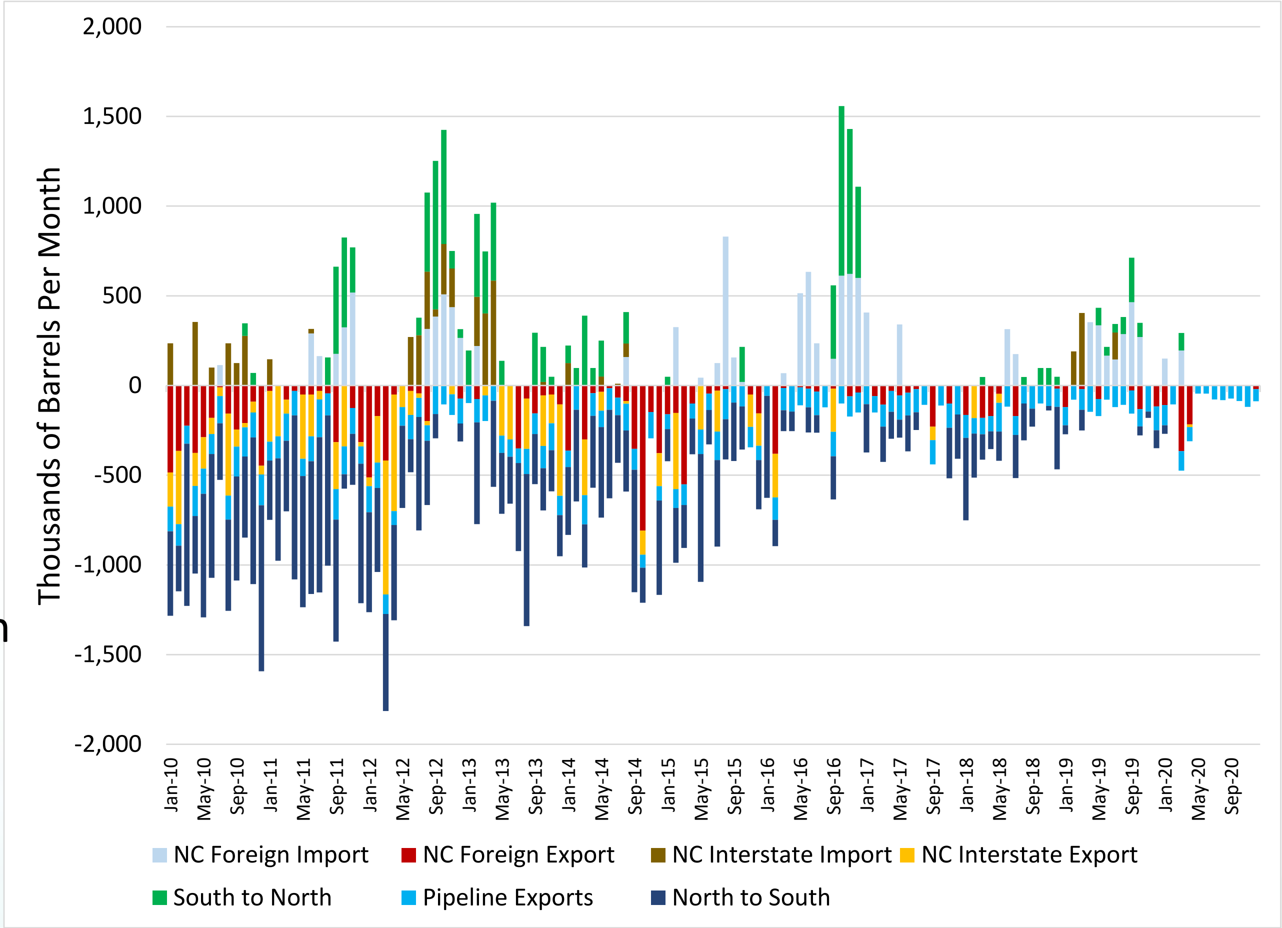
SF Bay Area – Kinder Morgan Lines



- The primary source of fuels for SF Bay Area airports is production from local refineries
  - Including supplies for Sacramento, Travis AFB, Fresno & Reno
- Trans-bay crossing to Brisbane & SFO
- Northern California refinery production periodically augmented with waterborne deliveries
  - Usually related to unplanned refinery outages
- At times, these imports have been as much as a third of average refinery production for a short period of time
- Marine terminals and pipeline connections not configured to transition to sustained marine importer of jet fuel

Jet Flows – Northern California

- Net exporter
- Imports intermittent – refinery outages
- Pipeline exports to Reno
- Domestic exports to PNW declined – replaced by WA refiners
- Exports to S. Calif. Have become a declining portion of their supply – recent volumes fluctuate based on refinery outages

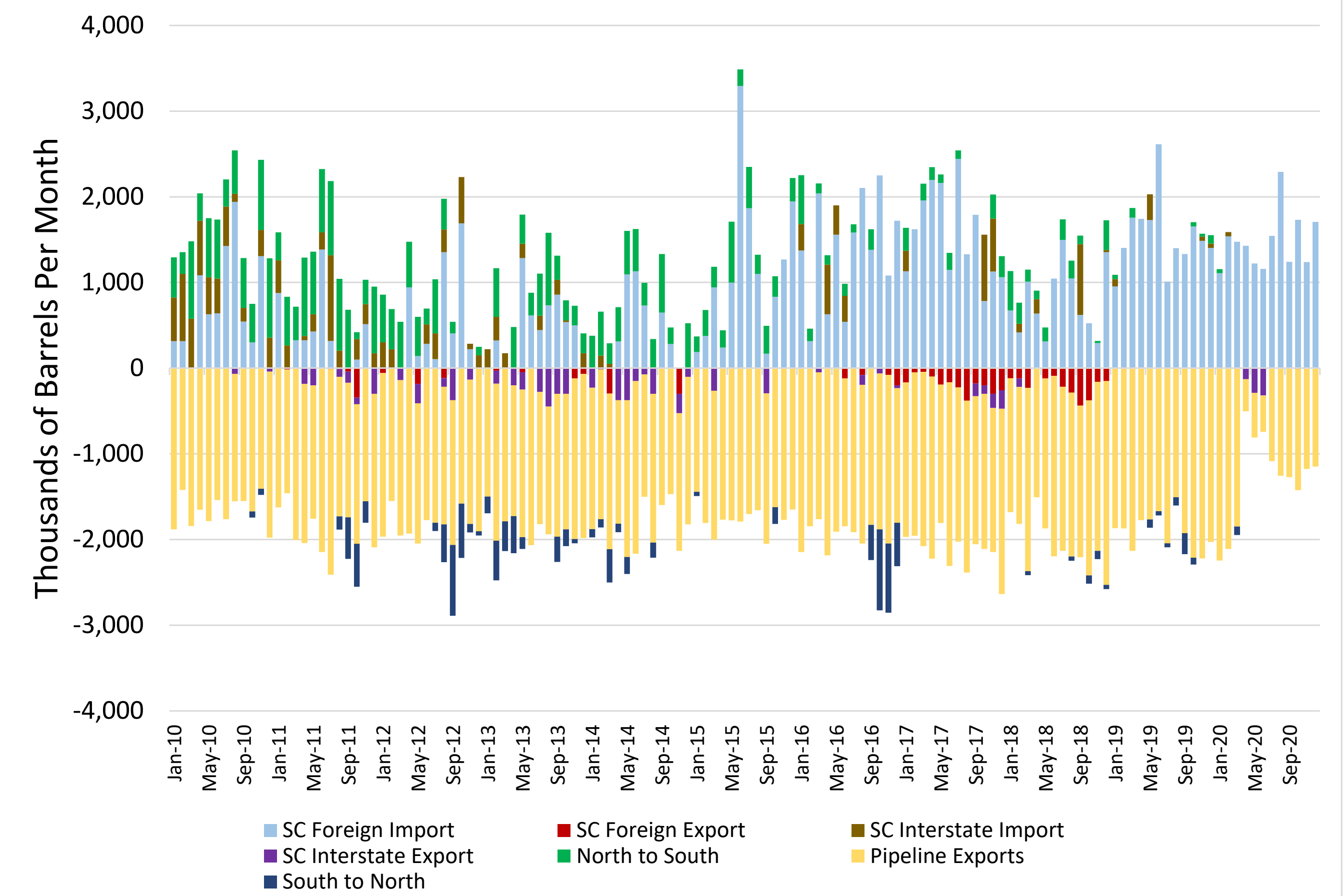


Local refinery production of jet fuel averaged 3.6 million barrels per month from 2017-2019

Source: California Energy Commission.

Jet Flows – Southern California

- Balanced imports & exports
- Foreign imports steady
- Other waterborne imports not needed
- Pipeline exports to AZ & NV
- Waterborne exports intermittent
- Exports to N. Calif. unusual

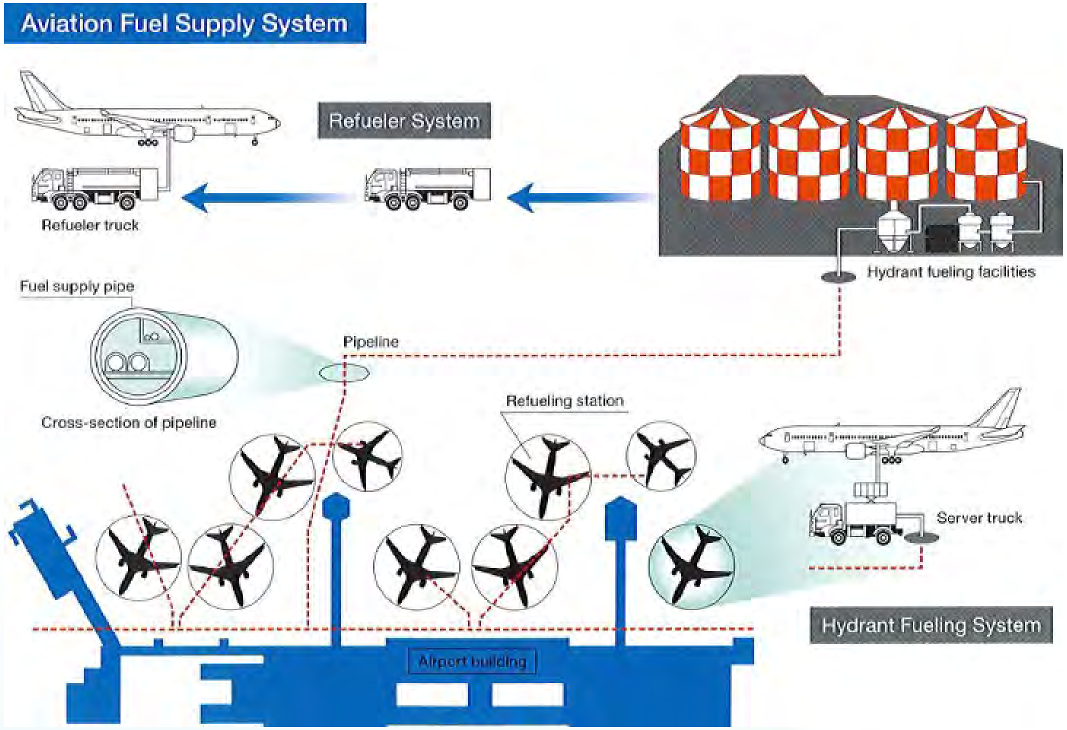


Local refinery production of jet fuel averaged 5.8 million barrels per month from 2017-2019

Source: California Energy Commission.

Jet Fuel - Logistics

- Nearly all commercial airports receive jet fuel via pipeline, not tanker truck
  - Very limited capability to unload tanker trucks
- Jet A dispensed into aircraft from:
  - Mobile refueling trucks sourcing fuel from onsite storage tanks
  - Server trucks sourcing from hydrant system
  - Both types of vehicles are specialized



Refinery Closures & Potential Impacts

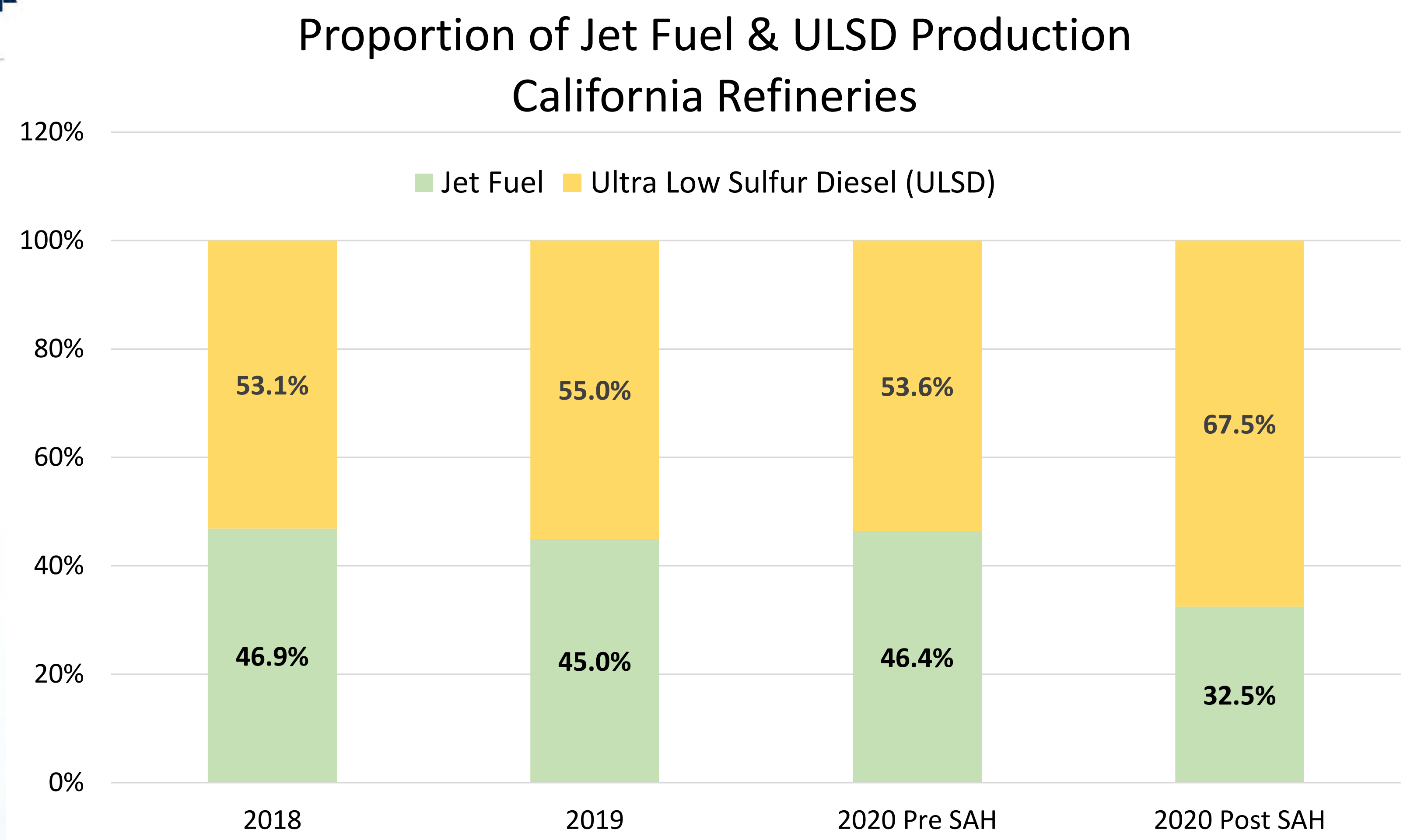
Recent Refinery Closures

- Refinery closures can occur when conditions of oversupply develop in a regional market due to Covid-19 fuel demand destruction
  - Marathon Martinez and Gallup refinery permanent idling – April 2020
  - Royal Dutch Shell Convent, Louisiana refinery – November 2020
- Closures tend to improve market conditions for other refiners in the region, diminishing degree of oversupply
  - Adequate supplies of transportation fuels still available for consumers and businesses
  - Usually a shift in source of supply through existing logistical infrastructure adequate to handle the changes
    - Marine terminals, pipeline connections/capacity & spare storage tank capacities

Recent Refinery Closures (cont.)

- Permanent idling of Marathon's Martinez refinery during late April 2020 did not result in any supply shortfall for transportation fuels due to:
- Decreased gasoline demand related to pandemic
  - Full recovery of gasoline demand to pre-pandemic levels uncertain
  - Influenced by size of workforce that maintains remote working, along with pace of transit ridership recovery
- Refinery operational changes to maximize diesel production at expense of jet fuel production
  - Diesel supplies still adequate since jet fuel demand remains depressed and renewable diesel imports and local production expected to grow over the near-term
- The Martinez refinery closure has decreased spare refinery production capacity in the state
  - As demand continues to recover for gasoline and jet fuel, future significant unplanned refinery outages could result in more severe and prolonged price spikes

Refiners Adjust Ratio of Jet Production

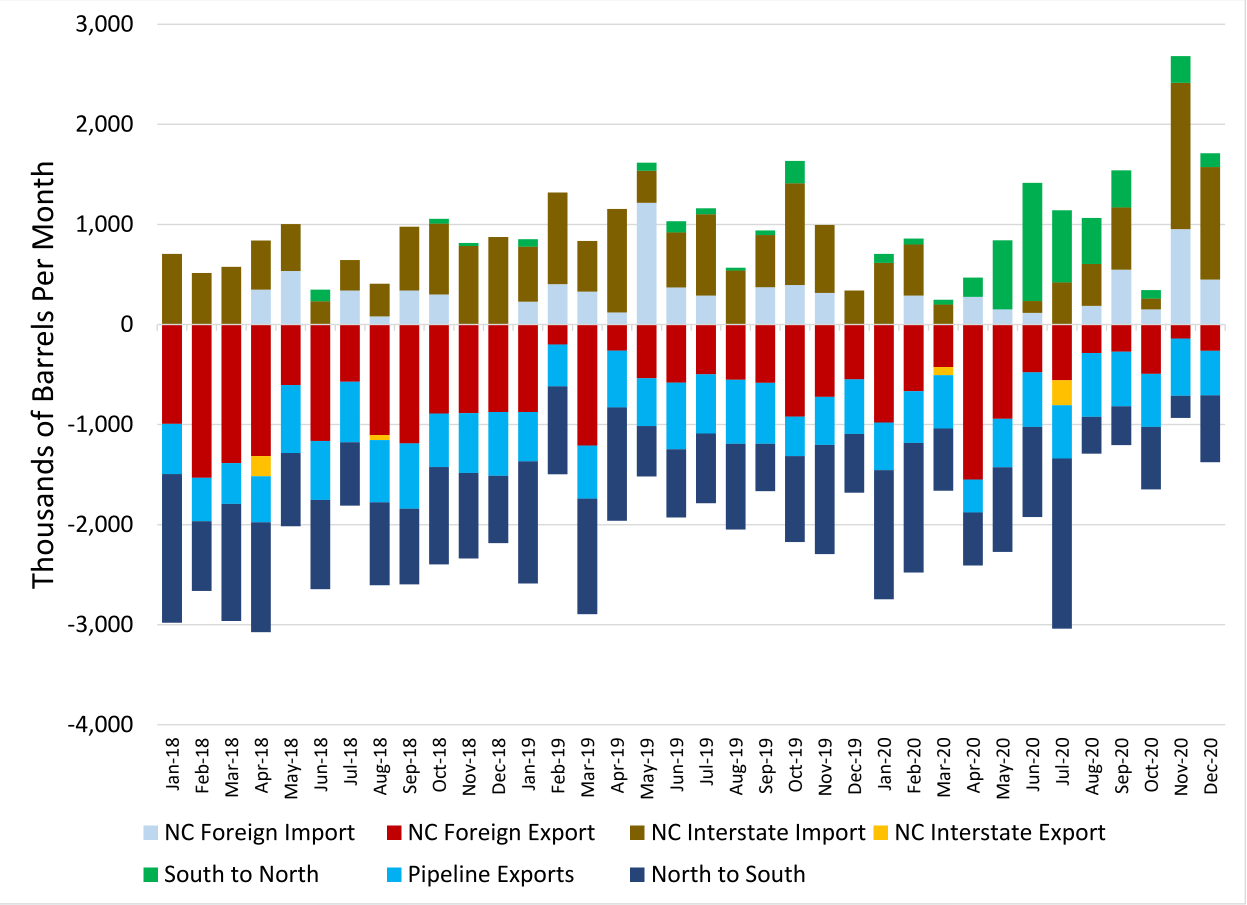


Source: Energy Commission analysis of Petroleum Industry Information Reporting Act data.

Note: 2020 Pre-Stay-at-Home (SAH) is average of data through week ending 3/13/20. Post SAH is average of data from week ending 3/20/2020 through week ending 4/23/2021.

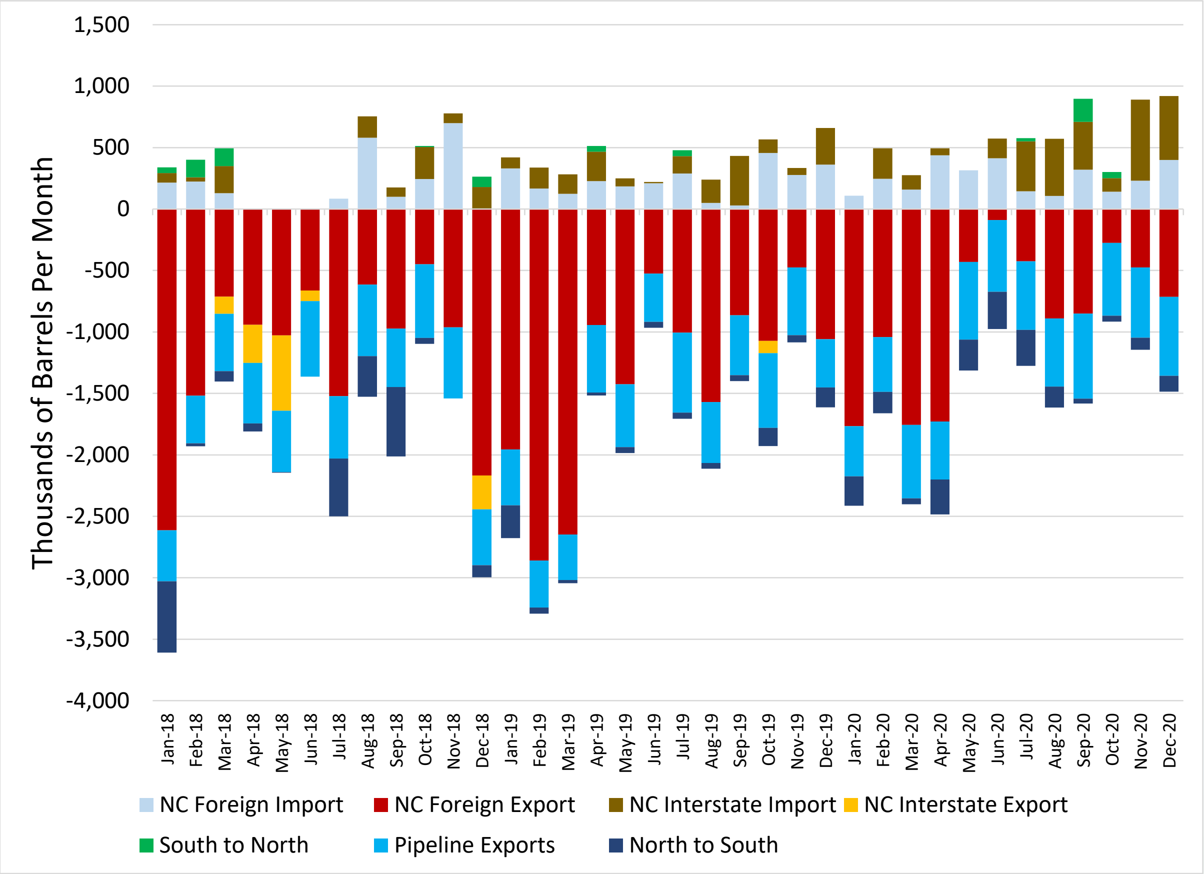
Gasolines Flows – Northern California

- Post closure of Martinez refinery – market rebalanced
- Marine exports declined
- Marine imports increased
- Most pronounced shift was increased reliance on supply from Southern California & the Pacific Northwest
- All of this change was manageable because demand was lower-than-normal due to the pandemic & incremental supply was readily available from nearby sources



Source: California Energy Commission.

Diesel Flows – Northern California



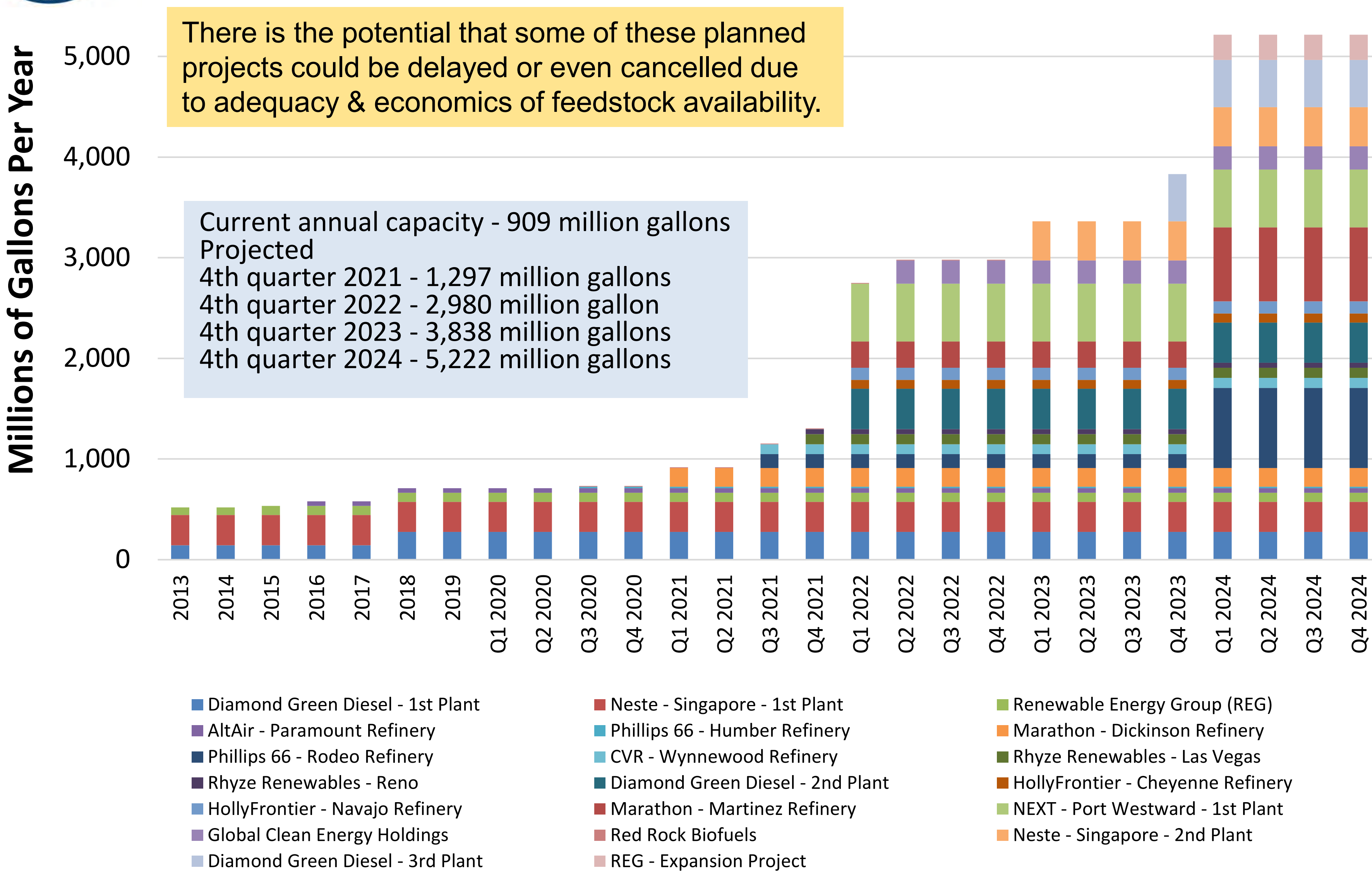
Source: California Energy Commission

- Similar change for diesel
- Post closure of Martinez refinery – market rebalanced
- Marine exports declined
- Marine imports increased
- Most pronounced shift was increased reliance on supply from Southern California & the Pacific Northwest
- All of this change was manageable, despite rebounding demand
    - Incremental supply was readily available from nearby sources
    - Higher ratio of diesel output from local refiners due to low jet fuel demand

Refinery Conversion Projects

- A refinery closure due to oversupply can also be accompanied by plans to cease traditional refining operations but convert some existing process equipment to produce different types of transportation fuels to meet new trends
  - Marathon – Martinez & Phillips 66 – Rodeo renewable fuel projects reflect such changes in operational plans
- Both companies see strong demand growth for renewable diesel fuel & sustainable aviation fuels
  - California Low Carbon Fuels Standard (LCFS), as well as other West Coast LCFS current (Oregon & British Colombia) and expected (Washington) regulations
  - Increasing demand for renewable diesel & jet fuel will displace additional volumes of fossil diesel and jet fuel over time, placing increased pressure on local refiners that continue producing fossil diesel
  - Decreased fossil diesel production and increased production/imports of renewable diesel help to better align with these growing trends

Increasing Renewable Diesel Availability

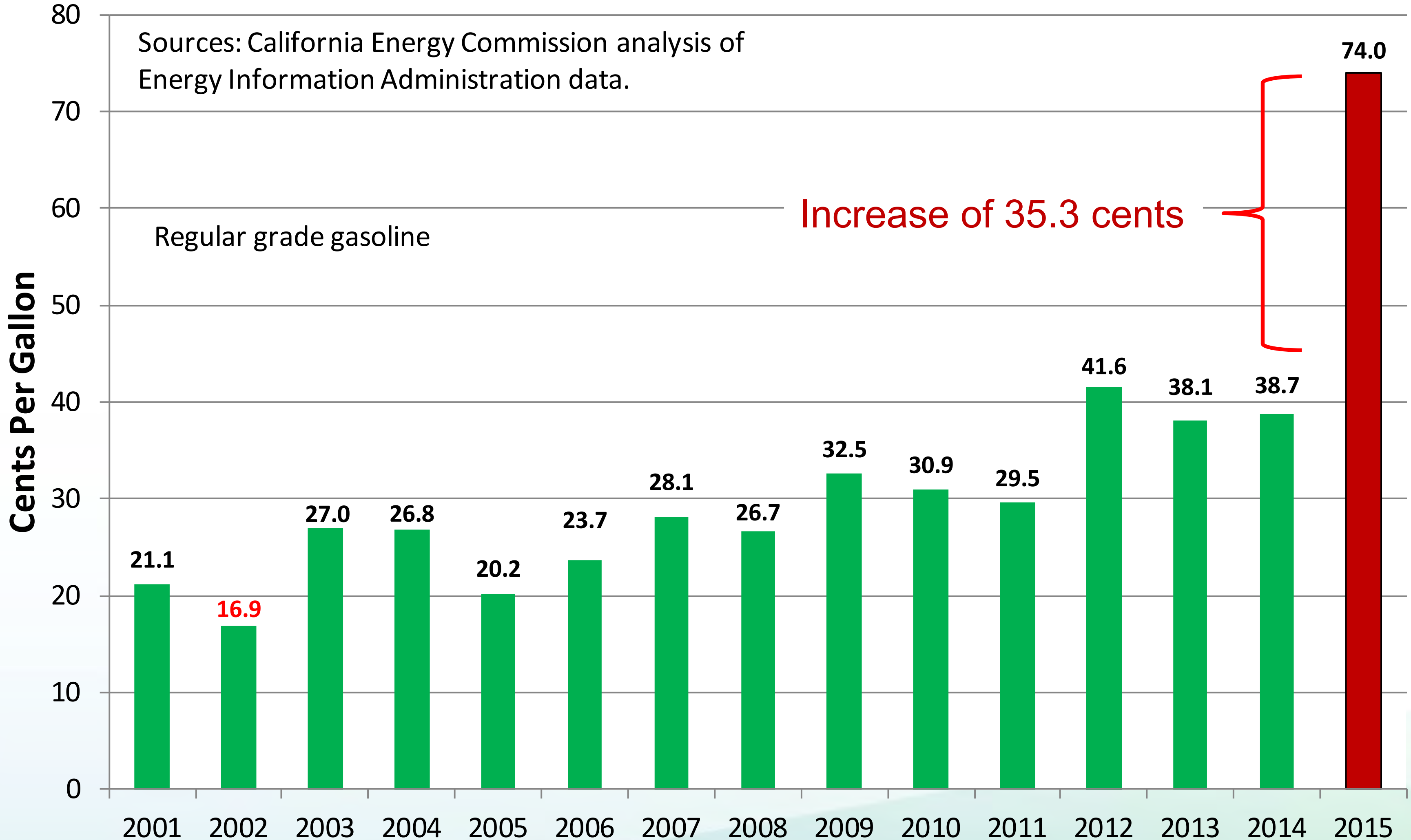


Source: California Energy Commission analysis of multiple reports and announcements.

Potential Impacts of Refinery Closures

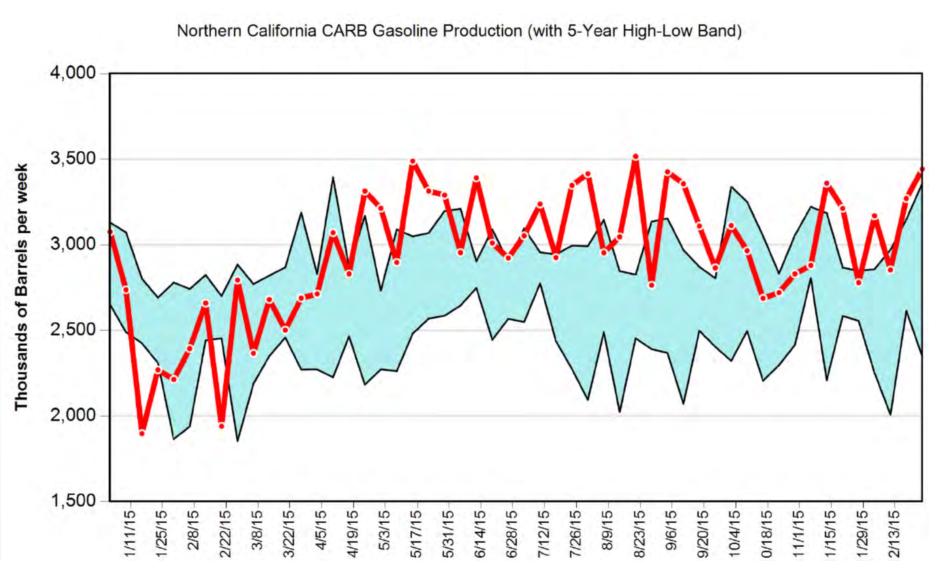
- Refinery closures can also occur when proposed refinery modification requirements exceed a company capital expenditure threshold that compels a premature refinery consolidation unrelated to changing fuel market trends
  - PBF Energy's letter & stated position to close facility if more stringent proposed standard is adopted
- A premature refinery closure could result in temporary fuel supply constraints that increase costs
  - Recent history illustrates the potential for fuel price increases
  - Torrance ESP explosion in 2015 & subsequent idling of gasoline producing equipment for 17 months
  - Statewide gasoline prices increased an average of 35 cents per gallon for drivers and businesses during 2015

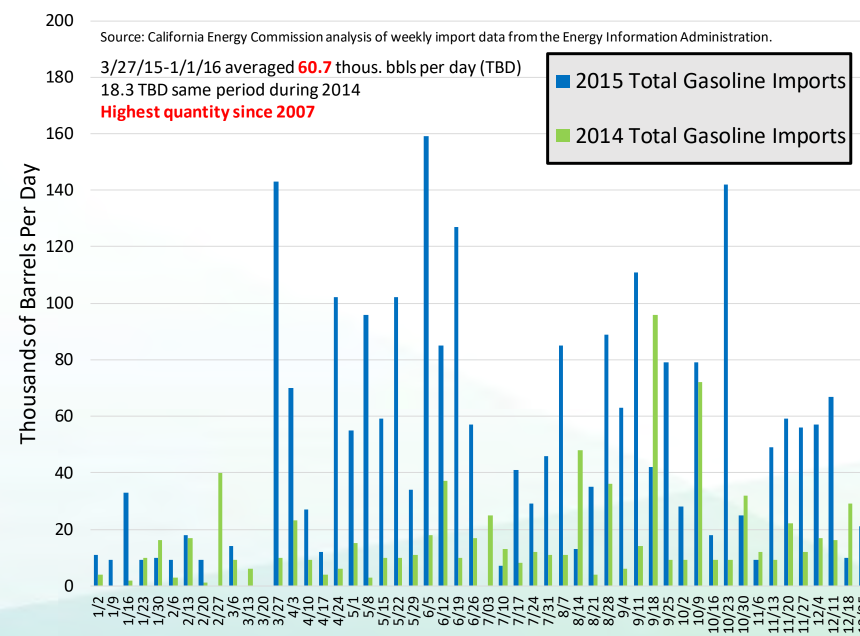
Retail Gasoline Price Differences California Less U.S. Average



Torrance Refinery Outage – Market Changes

- The loss of gasoline supply from the Torrance refinery resulted in a price spike of sufficient magnitude to incentivize:
  - Other California refiners to consistently over-produce gasoline during the higher demand season
  - Increased imports of more expensive gasoline and blending components at a higher level for a sustained period of time





Potential Impacts of Refinery Closures (cont.)

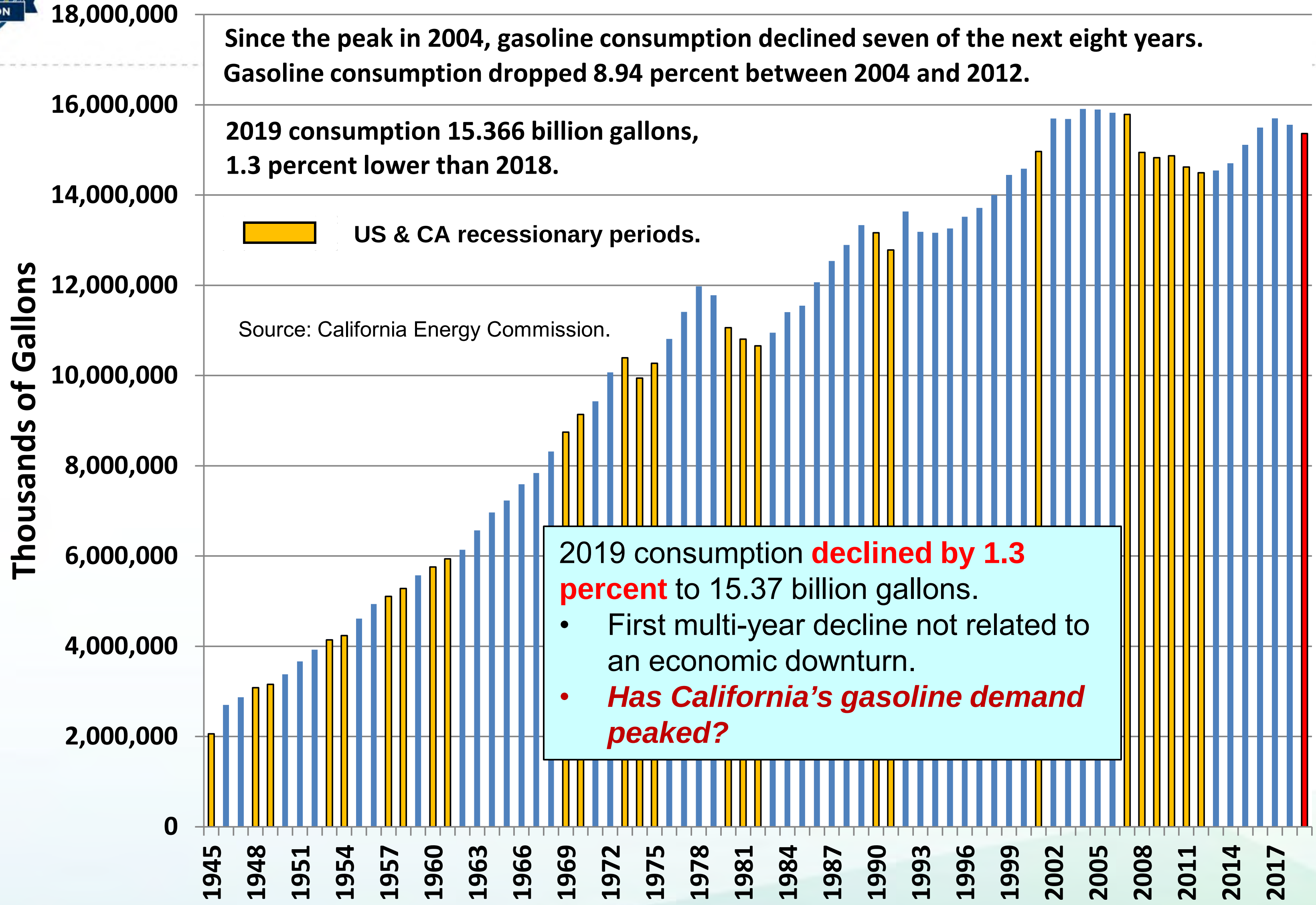
- A premature refinery closure over the near-term could result in even greater market impacts compared to the Torrance refinery outage in 2015-2016:
  - Could be worse due to decreased refinery spare production capacity in the state that has been diminished due to the permanent idling of the Marathon – Martinez refinery
  - Gasoline & diesel fuel supply/demand balances have been tightening with strong diesel fuel demand growth & continued gradual rebound in gasoline consumption
  - A return to higher jet fuel demand levels will remove additional flexibility from the marketplace
- However, over the longer-term, continued demand declines for gasoline & the continued erosion of fossil diesel fuel demand can create conditions of oversupply that could result in additional refinery consolidation due to these trends

Additional Questions

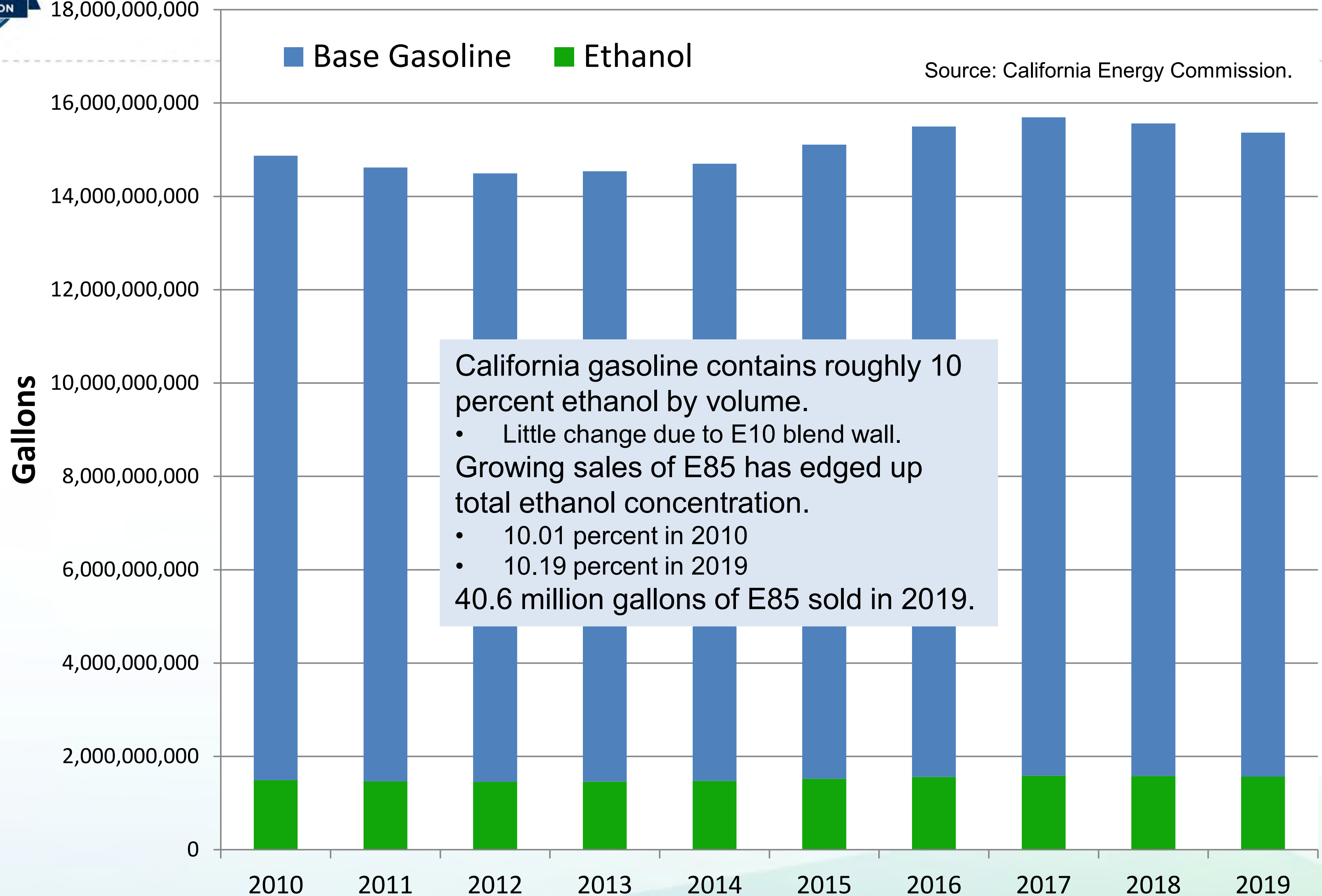
Scott's Oriole (male), Cat Creek, Palm Desert, CA - March 31, 2021.

Additional Information

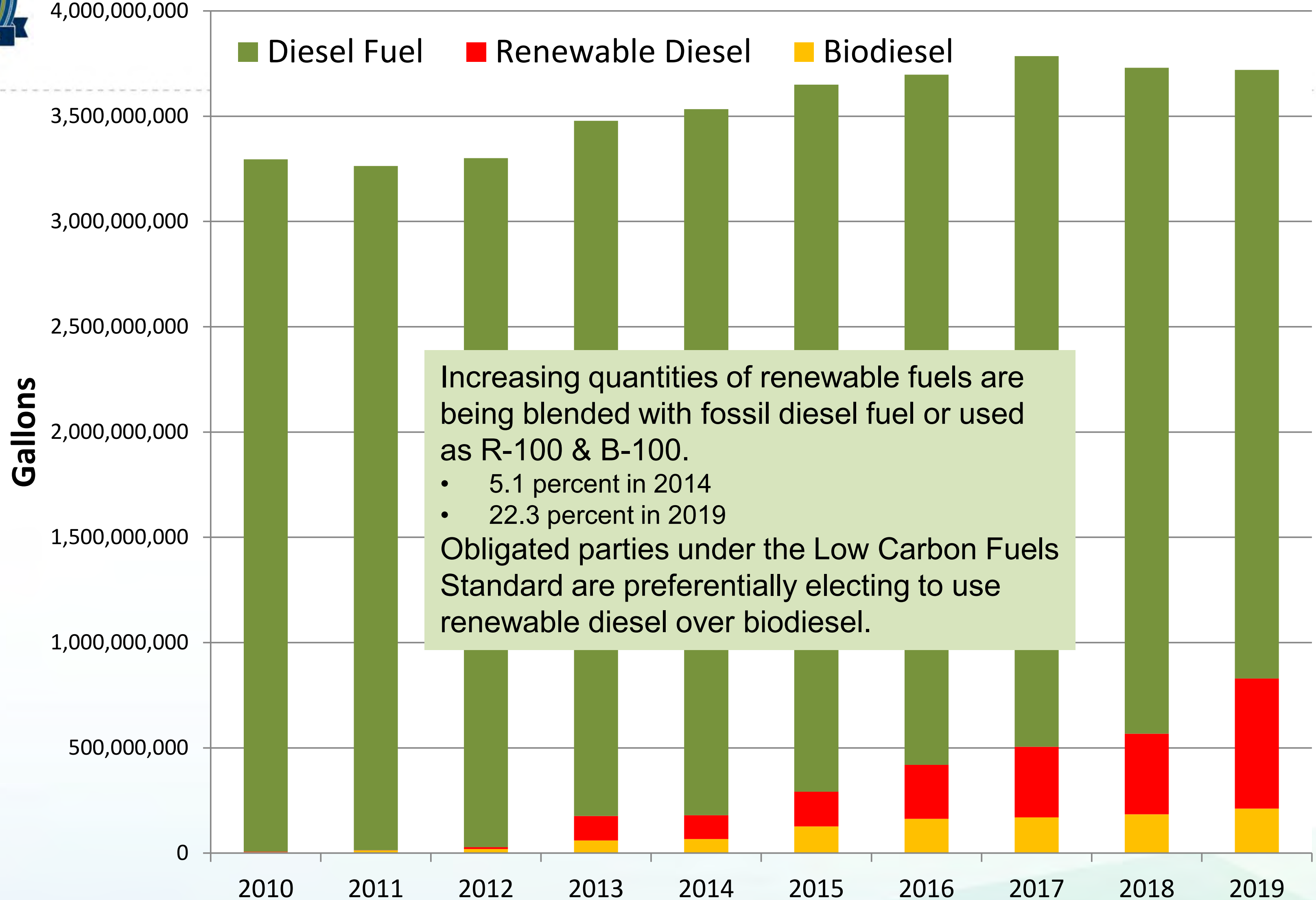
California Gasoline Use 1945-2019



Gasoline & Ethanol



Diesel & Renewables



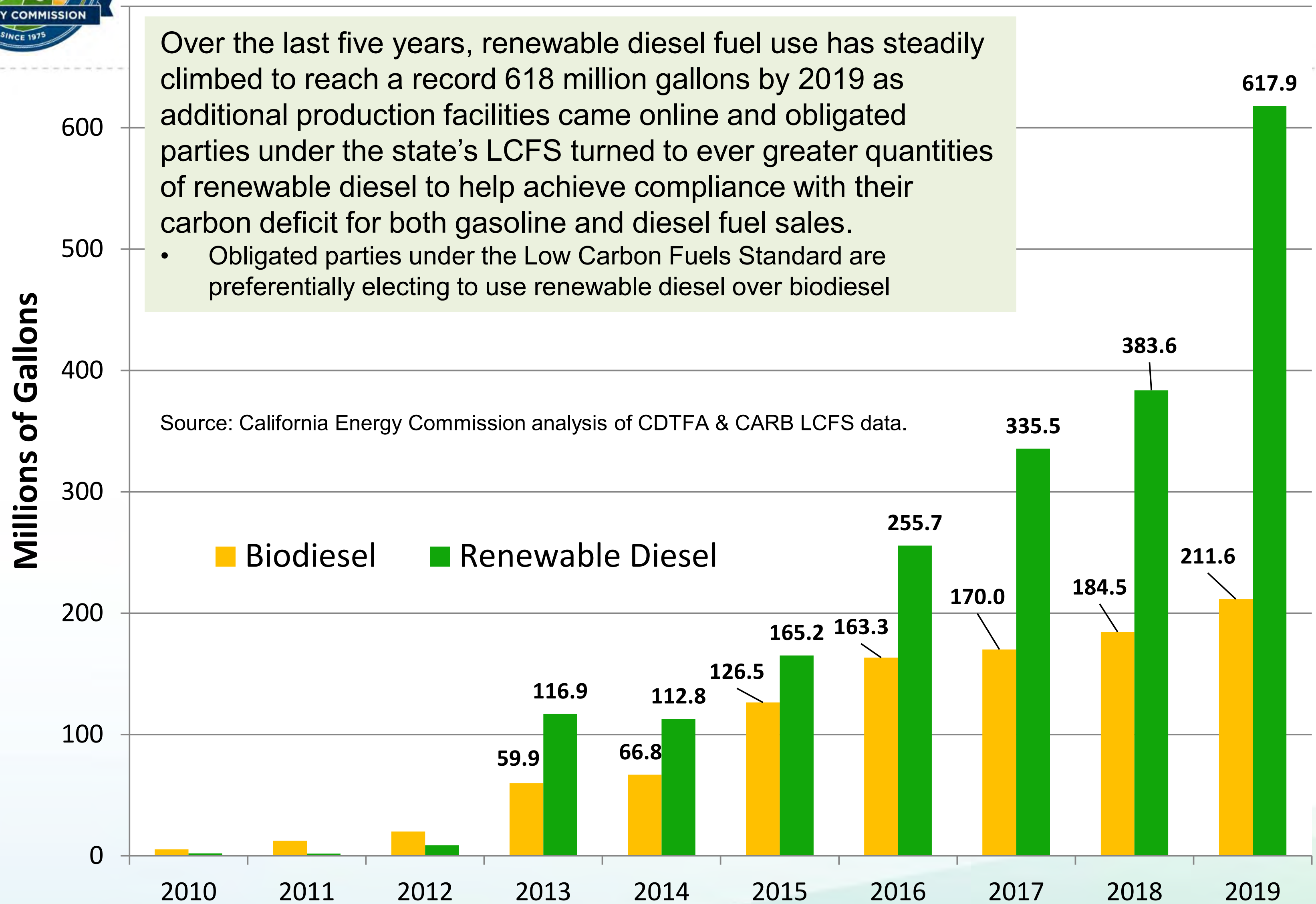
Source: California Energy Commission analysis of CDTFA & CARB LCFS data.

California Bio & Renewable Diesel Use

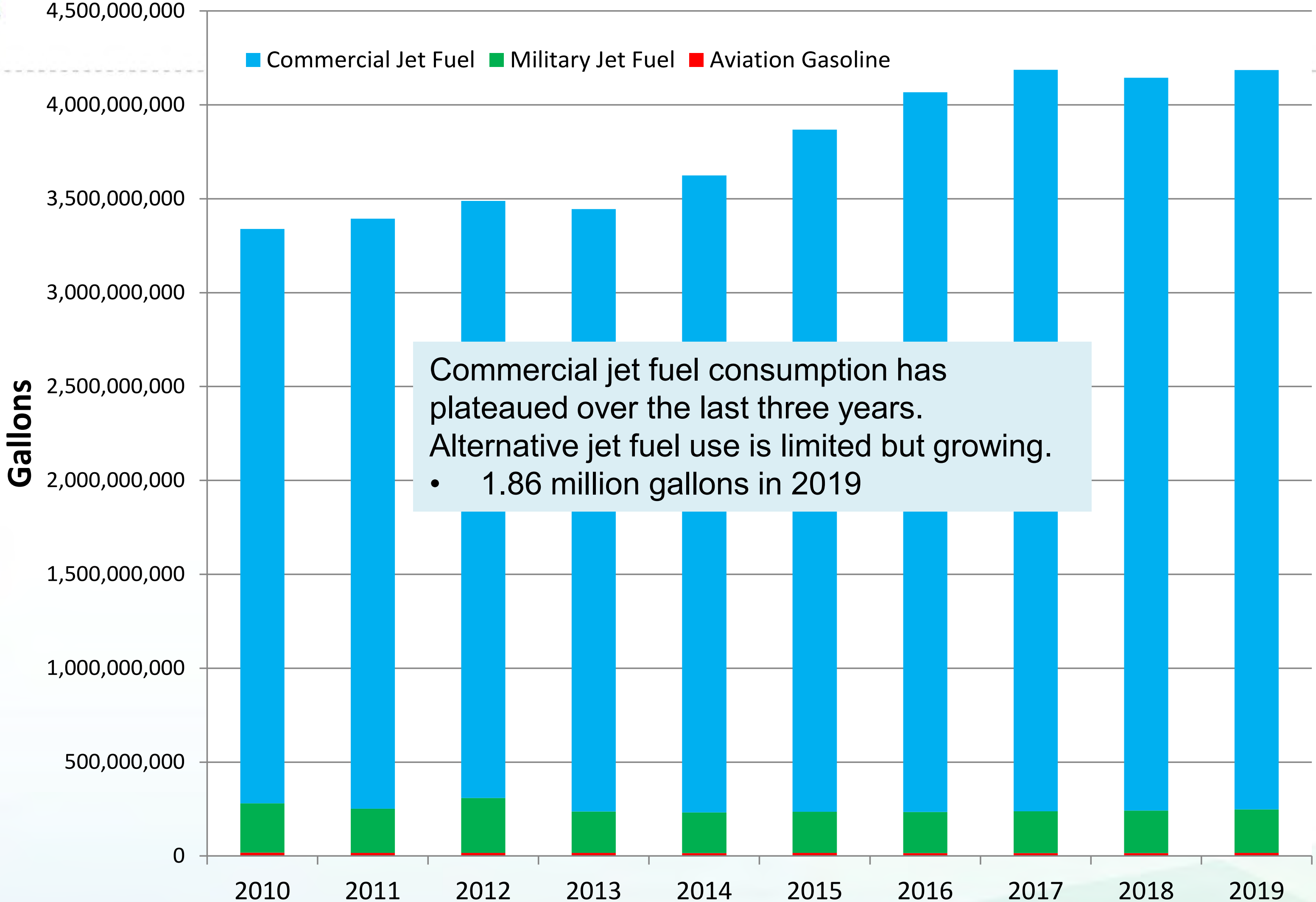
Over the last five years, renewable diesel fuel use has steadily climbed to reach a record 618 million gallons by 2019 as additional production facilities came online and obligated parties under the state's LCFS turned to ever greater quantities of renewable diesel to help achieve compliance with their carbon deficit for both gasoline and diesel fuel sales.

- Obligated parties under the Low Carbon Fuels Standard are preferentially electing to use renewable diesel over biodiesel

Source: California Energy Commission analysis of CDTFA & CARB LCFS data.

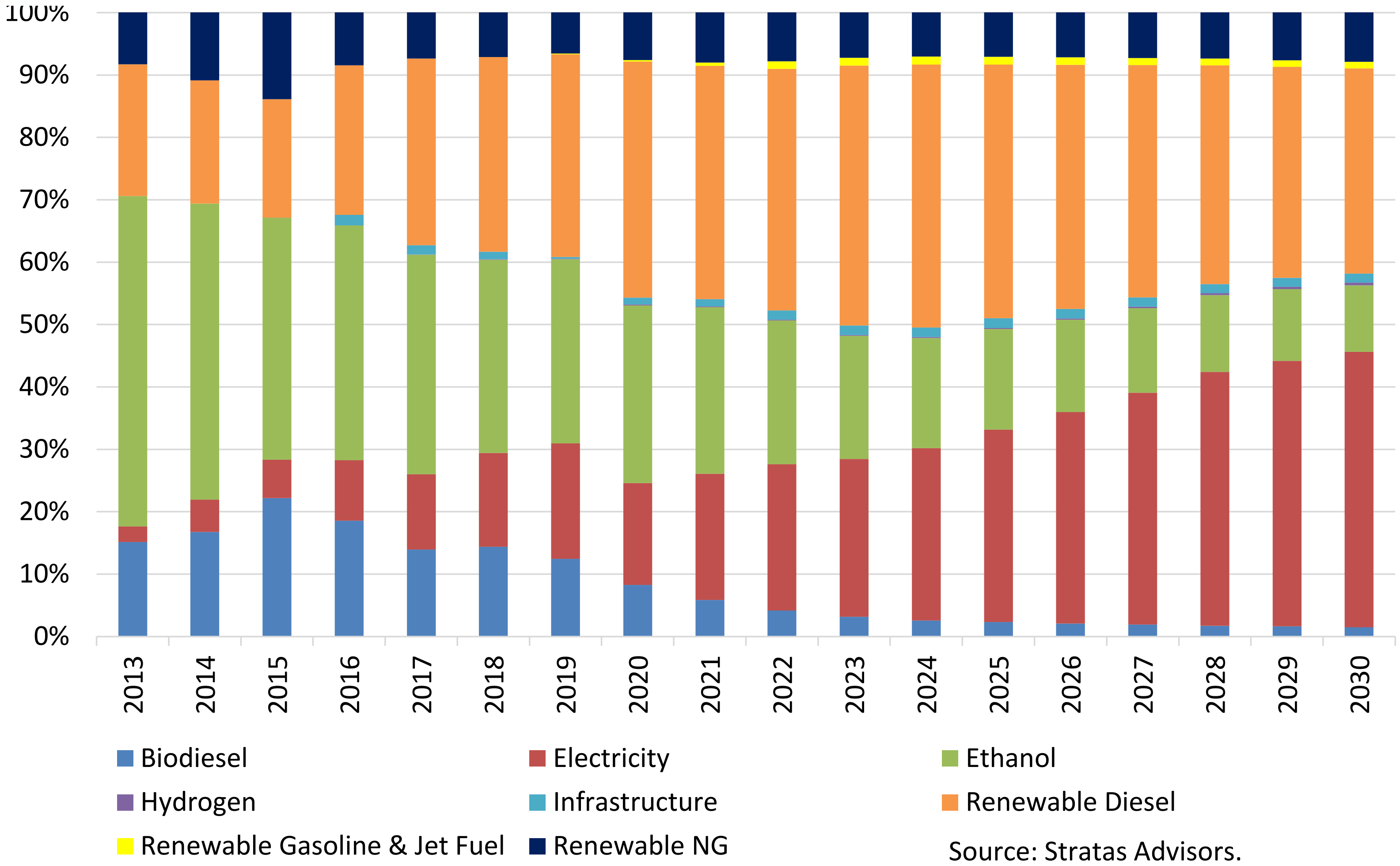


Aviation Fuels



Sources: California Energy Commission analysis of Petroleum Industry Information Reporting Act (PIIRA) & Energy Information Administration (EIA) data.

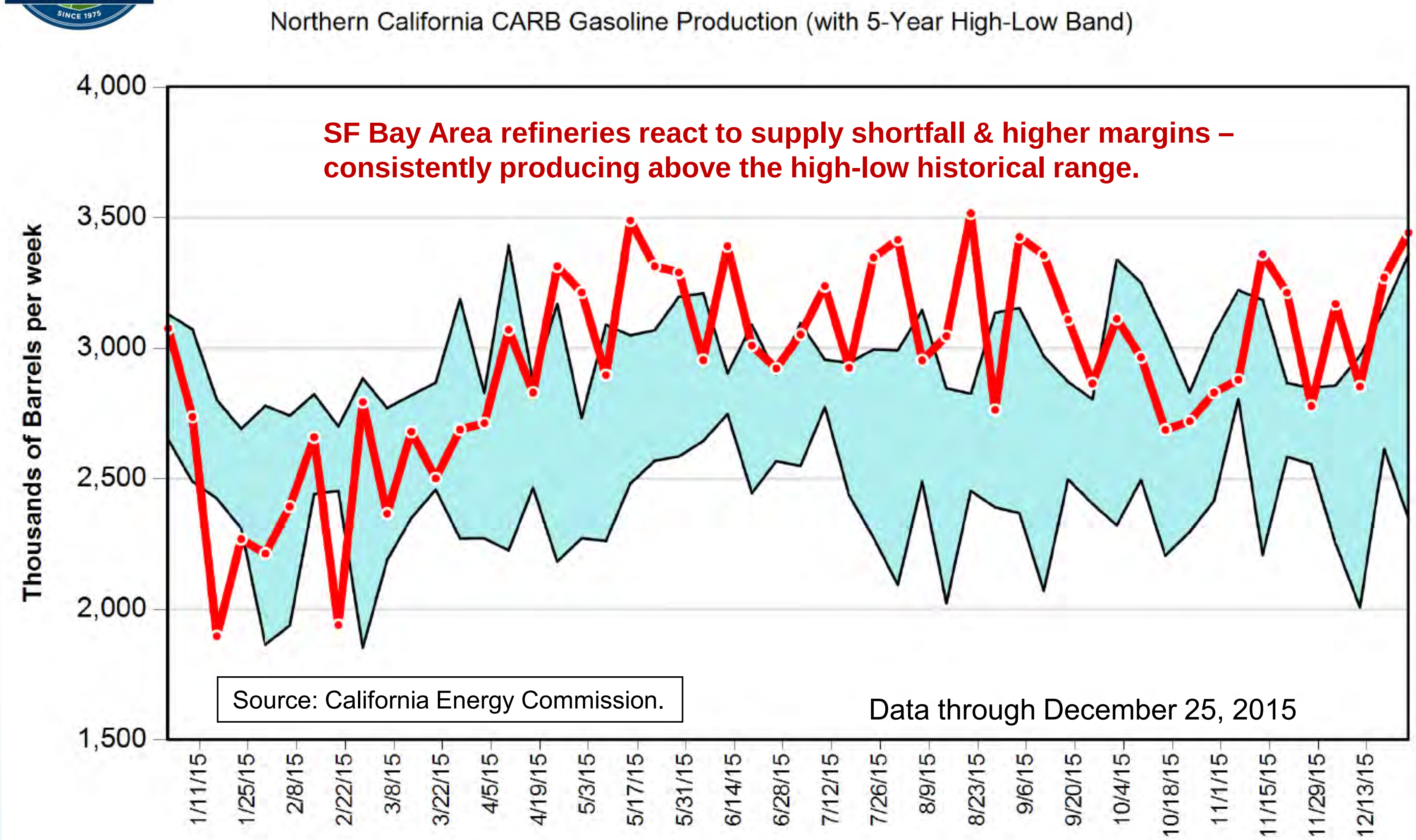
Low Carbon Fuels Standard
Historical & Projected Credit Useage



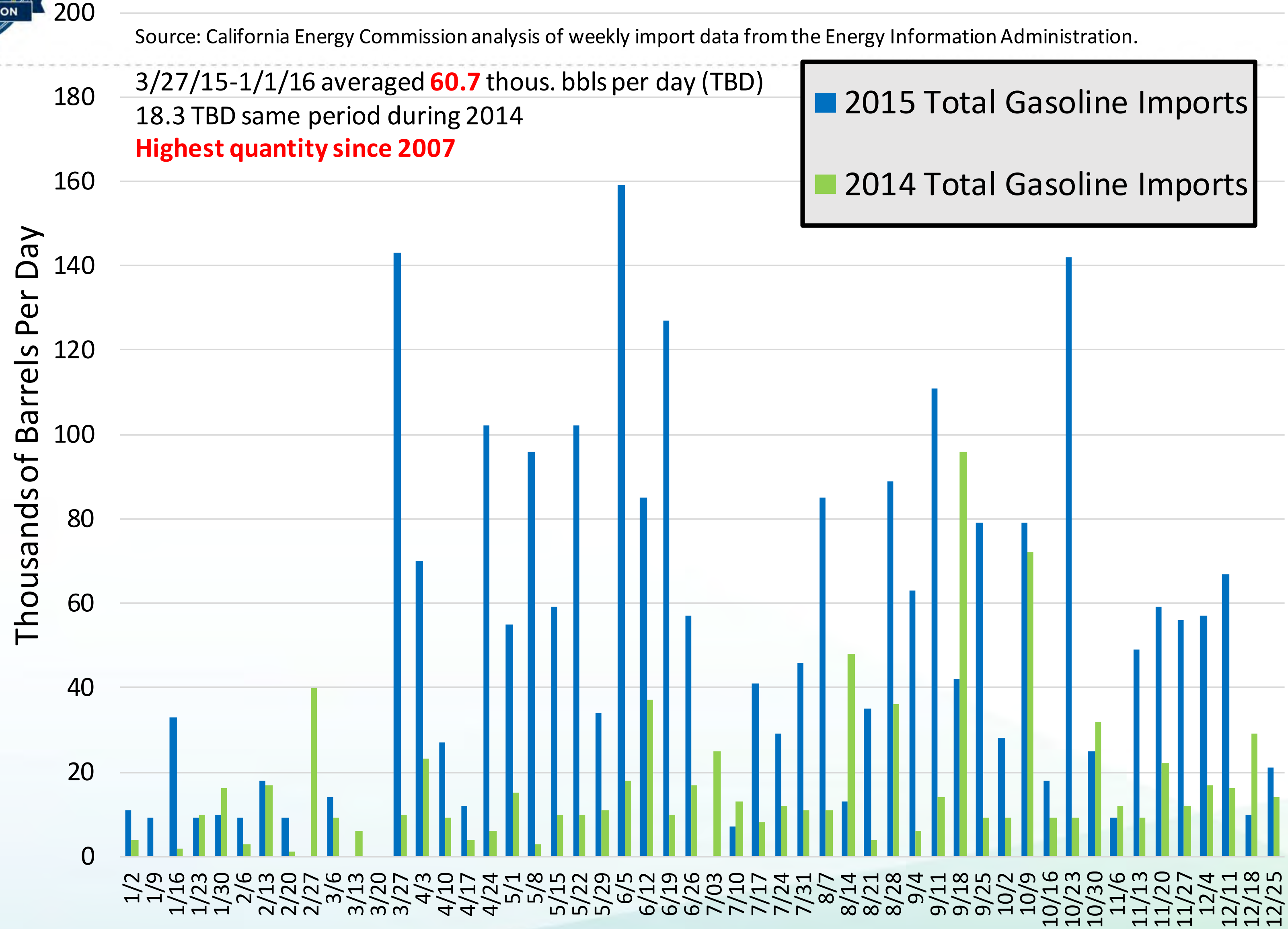
Source: Stratas Advisors.

Importance of renewable diesel for LCFS compliance forecast to grow and remain strong through 2030.

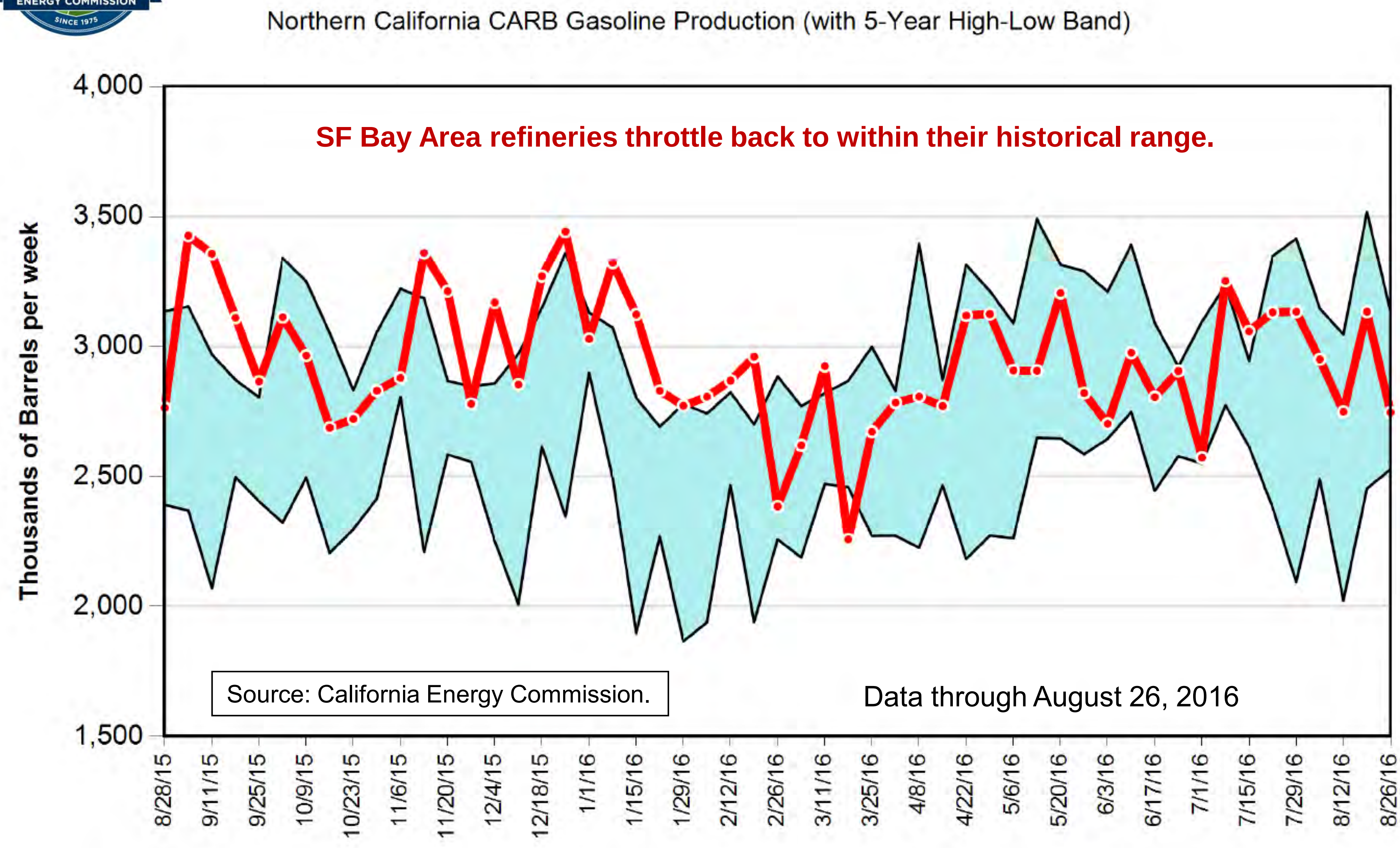
Gasoline Production - North



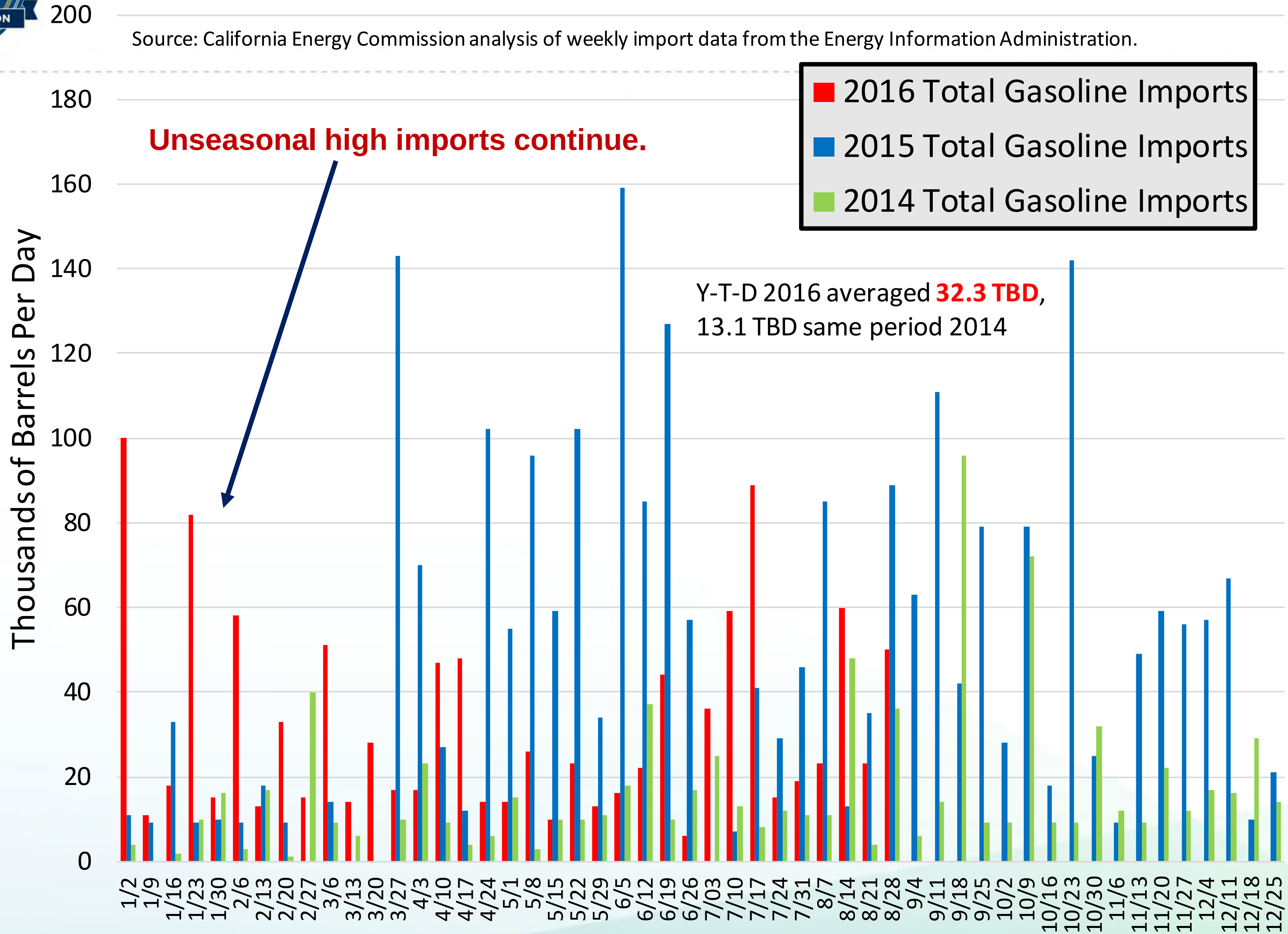
West Coast Foreign Gasoline Imports



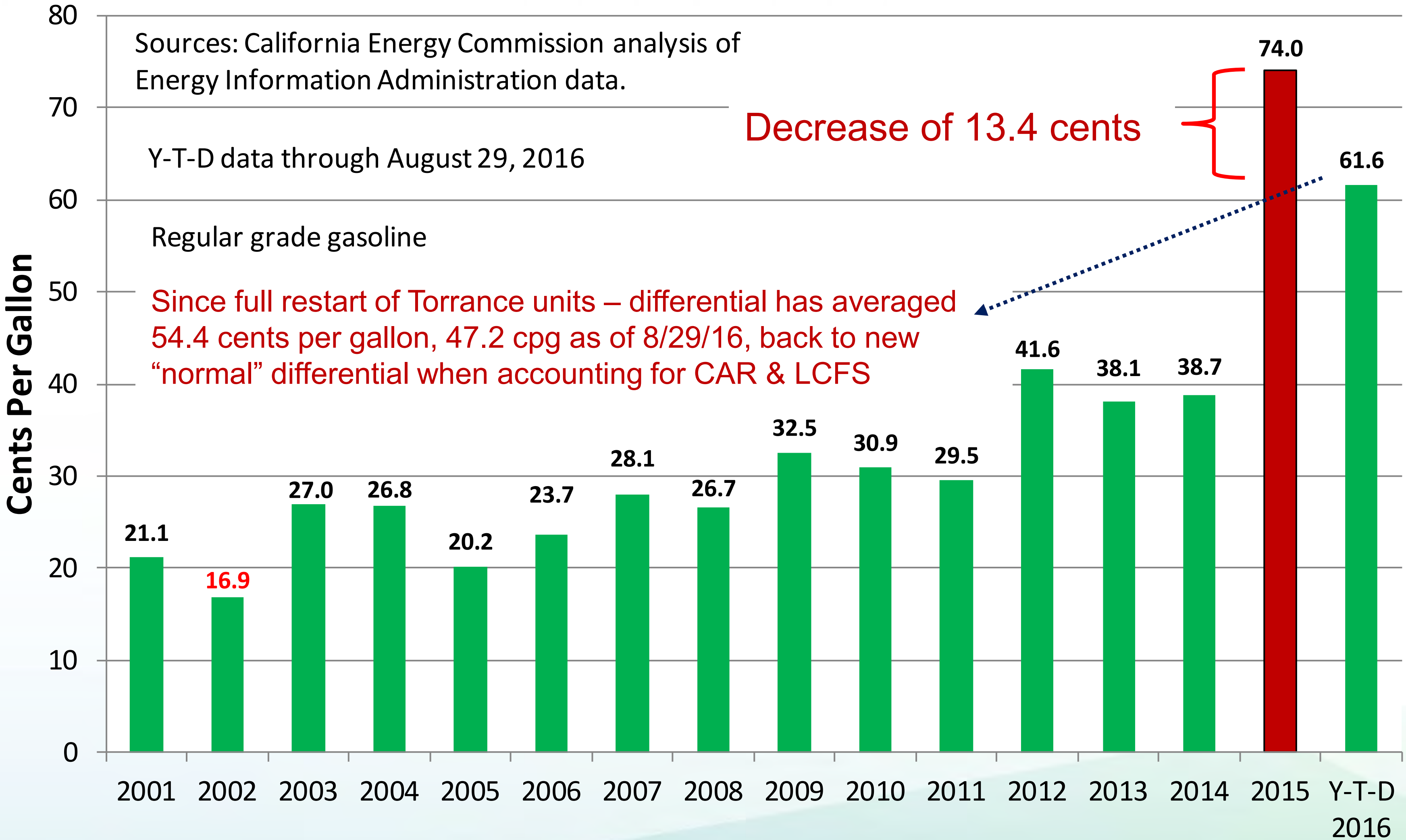
Gasoline Production - North



West Coast Foreign Gasoline Imports



Retail Gasoline Price Differences
California Less U.S. Average



Particulate Matter:
Spotlight on Health Protection

Advisory Council Particulate Matter Reduction Strategy Report

submitted to the Air District Board of Directors for review and consideration

December 16, 2020

Chair Stan Hayes
Dr. Severin Borenstein
Dr. Michael Kleinman
Dr. Tim Lipman
Dr. Jane Long
Dr. Linda Rudolph
Dr. Gina Solomon

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STATEMENT FROM THE EXECUTIVE OFFICER

Thank you for your interest in the Bay Area Air Quality Management District Advisory Council's *Particulate Matter Reduction Strategy Report*.

This report reflects the Bay Area Air Quality Management District's (Air District) recognition of the urgent need to reduce health impacts and health disparities from exposure to particulate matter (PM) at a time when federal leadership is retreating from this responsibility.

Under the Clean Air Act, the United States Environmental Protection Agency (U.S. EPA), with the assistance of the Clean Air Scientific Advisory Committee (CASAC), must review the latest scientific research and the health impacts of air pollutants regulated under the National Ambient Air Quality Standards (NAAQS). Recognizing the scope and significance of their work, the CASAC created a PM Review Committee to review the breadth of air quality science and provide expert insight.

However, in late 2018, the U.S. EPA, disregarding the science and the health impacts of air pollution, without notice disbanded the PM Review Committee. The work of the PM Review Committee, which was to review the U.S. EPA's Integrated Science Assessment on Particulate Matter, was left undone.

The body of scientific research and the guidance of experts is crucial in setting priorities and grounding new and innovative approaches to reducing particulate matter exposure. As an Air District, charged with improving air quality and public health, it has become our responsibility to step into the void created by the federal government and push these critical efforts forward.

Beginning in 2019, we turned to our Advisory Council to close this leadership gap and use its scientific expertise to help set the agenda for improving air quality. The Advisory Council has heard from experts around the country, including members of the disbanded PM Review Committee, as well as industry representatives and local community members and environmental activists who spoke about the lived impacts of exposure to particulate matter. Following these presentations and thoughtful deliberations, the Advisory Council has developed a roadmap to help guide us toward our common goal of a healthier Bay Area.

They have done this work in unprecedented times. Over this past year, we have grappled with a worldwide pandemic that has reshaped the way we live, work, educate, and socialize. The pandemic has laid bare systemic inequities like access to health care and disparities in health outcomes that disproportionately impact African American and Latinx communities. We have faced unprecedented levels of wildfire particulate matter, which has descended on the region for days, turning our skies orange, impacting public health, and compounding systemic inequities.

Aside from these wildfire events, over the past several decades, we have made significant strides toward cleaner air. More recently, groundbreaking programs like the Community Air Risk Evaluation Program, the Community Health Protection Program, and work done in response to Assembly Bill 617 have concentrated efforts to reduce exposure to air pollutants in the neighborhoods that are most impacted. But there is still more to do. Now, more than ever, as we face rising temperatures, changing climates, and persistent inequity, the Air District's work is imperative to ensure a better quality of life for everyone in the Bay Area.

We thank our Advisory Council members for their time and steadfast dedication. Their leadership is invaluable in helping us recognize immediate steps we can take to reduce particulate matter in the region. We at the Air District remain committed to our public and environmental health mission, as we endeavor together to ensure a healthier Bay Area for every resident and future generations.

Jack P. Broadbent

Jack P. Broadbent
Executive Officer/Air Pollution Control Officer (APCO)

INTRODUCTION

As the first regional air pollution control agency in the nation, predating U.S. EPA by 15 years, the Air District has led the vanguard on environmental efforts for more than six decades. From establishing the nation's first regional air quality monitoring program and integrated regional air quality ozone model, to developing landmark odor regulations and controls on emissions from numerous sources including aerosol spray products, the Air District has continually pioneered increasingly ambitious, comprehensive, and innovative efforts to improve air quality and protect the health of Bay Area residents.

The events of recent years have made this leadership even more critical. Whereas the establishment of the U.S. EPA in 1970 and subsequent Clean Air Act Amendments had enabled the Air District to rely on the considerable resources of the federal government for scientific research and expertise concerning the health impacts of air quality and federal air quality standards, the current federal administration has abandoned this role. In 2018, the U.S. EPA dismissed, via press release, the expert Particulate Matter Review Panel charged with reviewing its assessment of the most current science.

Facing this federal leadership void and recognizing that particulate matter is a major driver of health risks from Bay Area air quality, the Air District and Advisory Council convened the Particulate Matter Symposium Series. The goal of the series was to clarify the state of the science; outline current and forthcoming Air District work; learn about local community efforts, needs, and priorities; and hear from industry representatives. In particular, the Air District and Advisory Council sought to understand how best to improve air quality conditions for communities that are most at risk.

ADVISORY COUNCIL SYMPOSIUM SERIES

The October 2019 PM Symposium facilitated a discussion among nationally recognized scientists, stakeholders, and the Air District on particulate matter and health impacts. In December 2019, the Advisory Council received presentations from Air District staff on current and forthcoming particulate matter reduction strategies. In May and July, via webcast due to the COVID-19 pandemic, the Advisory Council received presentations from community members and environmental activists on the local environmental health effects of particulate matter, in addition to hearing from local industry representatives who shared their perspectives on the science.

Throughout the past year, in order to further inform Advisory Council deliberations and discussions, Air District staff members and representatives from state-level agencies have also presented to the Advisory Council on particulate matter initiatives, research activities, air quality modeling, and measurement and monitoring efforts.

October 28, 2019

Particulate Matter Symposium: Health Effects, Exposure and Risk

- *300+ registrants; many participated online*
- *Two panels: PM Health Effects & PM Exposure & Risk*
- *9 leading experts*

DECEMBER 9, 2019

Advisory Council Meeting: BAAQMD Update on Current and Emerging Efforts on Particulate Matter

FEBRUARY 27, 2020

Community Particulate Matter Discussion

Air District staff met with approx. 30 community members from approx. 16 organizations

MAY 12, 2020

Advisory Council Meeting: Community Presentations and Air District Update on PM Potential Policy Strategies

- *Presentations from Jed Holtzman, MEM, 350 Bay Area and LaDonna Williams, All Positives Possible*
- *Presentation from Greg Nudd, Air District*

JUNE 29 – JULY 2, 2020

Air and Waste Management Association Panel: Developing a Path Forward for $PM_{2.5}$ Regulation in the Bay Area

Together with Air District staff, Advisory Council members host a panel at the annual Air & Waste Management Association Conference & Exhibition

JULY 31, 2020

Advisory Council Meeting: Regulated Industry Presentations and Air District Presentation on Bay Area PM Modeling-Based Assessments and Next Steps

- *Presentations from Frances Keeler, CCEEB and Dr. Julie E. Goodman on behalf of WSPA*
- *Presentation from Dr. Phil Martien, Air District*

OCTOBER 9, 2020

Advisory Council Meeting: *Advisory Council members continue discussions from the July 31, 2020, meeting on reducing fine particulate matter in the region*

NOVEMBER 9, 2020

Advisory Council Meeting: *Advisory Council members continue discussions from the July 31, 2020, and October 9, 2020, meetings on reducing fine particulate matter in the region*

DECEMBER 16, 2020

Joint meeting of the Advisory Council and Board of Directors to present and discuss particulate matter reduction strategy

Having received input from scientific experts, community and environmental activists, industry representatives, and Air District and state air quality staff, and with the benefit of its own expertise, the Advisory Council has developed a series of findings and recommendations to help advance the Air District's mission to achieve a healthier Bay Area by reaching for clean air targets beyond state and federal standards.

This document presents these findings along with a framework for evaluating particulate matter reduction strategies into the future. The report also gathers recommended actions as a roadmap for the Air District to consider as it continues work to lower particulate matter exposure throughout the region.

The particulate matter reduction statements, framework, and recommended actions collectively reflect the new imperative for the Air District to lead the country in utilizing the best science available to set ambitious targets for cleaner air and better protect health in every Bay Area community and neighborhood.

ABOUT THE ADVISORY COUNCIL

The Air District's Advisory Council was created in concordance with guidelines in the California Health and Safety Code (Section 40260-40268). The Advisory Council comprises seven members with expertise in air pollution, climate change, and/or the health impacts of air pollution. The Advisory Council advises and consults with the Board of Directors and the Executive Office on technical and policy matters. In 2019, the Air District asked the Advisory Council to provide expert input and guidance on particulate matter reduction strategies in the Bay Area region. More information and Advisory Council member biographies can be found in Appendix D.

ABOUT THE AIR DISTRICT

The California Legislature created the Air District in 1955 as the first regional air pollution control agency in the country. The Air District is tasked with regulating stationary sources of air pollution in the nine counties that surround San Francisco Bay: Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, southwestern Solano, and southern Sonoma counties. It is governed by a 24-member Board of Directors composed of locally elected officials from each of the nine Bay Area counties, with the number of board members from each county based proportionately on its population.

The Board of Directors oversees policies and adopts regulations for the control of air pollution within the district. The Board of Directors also appoints the Air District's Executive Officer/Air Pollution Control Officer, who implements these policies and gives direction to staff, as well as the Air District Counsel, who manages the legal affairs of the agency. The Air District consists of nearly 400 dedicated staff members, including engineers, inspectors, planners, scientists, and other professionals.

PARTICULATE MATTER REDUCTION STATEMENTS

The Advisory Council has gathered evidence on the current state of particulate matter science and the health impacts and risks of particulate matter exposure. The statements reflecting their findings are provided below, and together ground the Air District's future particulate matter reduction initiatives in science and the interest of public health. These statements are as follows:

PMRS1) Particulate Matter (PM) is the most important health risk driver in Bay Area air quality, both $PM_{2.5}$ as a criteria pollutant and diesel PM as a toxic air contaminant.

PMRS2) The Bay Area has made substantial progress at reducing regional $PM_{2.5}$ levels to meet current $PM_{2.5}$ standards; however, 1) more stringent standards would be more health protective; 2) exposures vary substantially across communities; and 3) wildfire smoke increases $PM_{2.5}$ levels substantially above standards.

PMRS3) The current particulate matter national ambient air quality standards (NAAQS) are not health protective.

> *The Advisory Council concurs with the following statement: "Based on scientific evidence, as detailed in Attachment B [of our letter], the [Independent Particulate Matter Review Panel] finds that the current suite of primary fine particle ($PM_{2.5}$) annual and 24-hour standards are not protective of public health. Both of these standards should be revised to new levels, while retaining their current indicators, averaging times, and forms. The annual standard should be revised to a range of 10 μg/m^3 to 8 μg/m^3. The 24-hour standard should be revised to a range of 30 μg/m^3 to 25 μg/m^3. These scientific findings are based on consistent epidemiological evidence from multiple multi-city studies, augmented with evidence from single-city studies, at policy-relevant ambient concentrations in areas with design values at and below the levels of the current standards, and are supported by research from experimental models in animals and humans and by accountability studies." (Independent Particulate Review Panel Letter on Draft EPA PM Policy Assessment, October 2019).*

PMRS4) More stringent standards to reduce exposures are urgently needed, and, if met, would save thousands of lives in the U.S. and many Bay Area lives each year.

PMRS5) There is no known threshold for harmful $PM_{2.5}$ health effects; thus, it follows that additional reductions of $PM_{2.5}$ concentrations will achieve additional public health benefits.

PMRS6) An Air District guideline "target" below the current PM2.5 NAAQS is warranted to protect public health; if the Air District were to set that target at an annual average of as low as 8 µg/m3, U.S. EPA's $PM_{2.5}$ NAAQS risk assessment provides scientific evidence that annual average targets in that range would save additional lives.

PMRS7) Although a large fraction of PM2.5 is regionally contributed, substantially elevated PM2.5 exposures can occur in locations adjacent to local PM sources. Therefore, controlling emissions in these local impacted areas is of primary importance.

PMRS8) Wildfire PM is a serious contributor to PM health effects; early health studies are of concern; more research on acute and sub-chronic effects is ongoing and urgently needed. Wildfire PM exposure is projected to increase in duration and intensity, due to climate change, and this justifies greater efforts to reduce controllable sources of PM to reduce overall health risk.

PMRS9) Some species of PM may be more dangerous than others; as yet, no PM species can be exonerated.

PMRS10) Ultrafine particles (UFP), which are present in the air in large numbers, pose a health risk, but are not adequately monitored. They generally enter the body through the upper and lower respiratory tract and can translocate to essentially all organs. Compared to fine particles ($PM_{2.5}$), they cause more pulmonary inflammation per unit mass, and are retained longer in the lung.

FRAMEWORK FOR EVALUATING PARTICULATE MATTER REDUCTION STRATEGIES

As the Air District approaches the task of reducing particulate matter in the Bay Area, strategies under consideration should be evaluated using the following framework with particular priority given to PM reductions in communities that are most heavily impacted, and especially recognizing the Board's unanimous adoption of Resolution 2020-08, "Condemning Racism and Injustice and Affirming Commitment to Diversity, Equity, Access and Inclusion."

F1) The Air District should move as quickly as possible to take maximal feasible action within its authority to reduce emissions from PM sources, prioritizing the most impacted areas.

F2) PM reduction strategies should prioritize those measures that are most effective in reducing exposure and improving public health and health equity in the most impacted areas.

F3) Local strategies should account for the fact that the most effective exposure reduction measures may differ across communities, due to varying source mix and size, ambient PM concentration levels, physical circumstances (e.g., meteorology, terrain), and other relevant factors.

F4) The Air District should focus PM reduction in areas with elevated exposures, health vulnerability, and those areas with increased impacts and sensitive populations (e.g., U.S. EPA identifies children, non-white, low socioeconomic status, elderly).

F5) PM reduction strategies for highly-impacted communities must include control of the cumulative impact of regional (Bay Area-wide), local (community-level), and localized hot-spot (block-level) sources.

F6) PM reduction strategies should include emission reduction measures for both primary PM and secondary PM formed in the air (e.g., emissions of precursor ROG, NOx, NH_3, and SO_2).

F7) PM reduction strategies will need to address multiple source categories with a wide range of emission reduction measures, and may vary with location; there are no single, universal solutions.

RECOMMENDED ACTIONS

The Advisory Council, in consideration of input from scientists, Air District staff, and industry and community representatives, have identified several actions the Air District can take to reduce particulate matter in the region. These recommended actions are categorized into key priorities reflected in the Particulate Matter Reduction Statements and Framework. Recommended actions include, but are not limited to, the following:

ESTABLISH MORE HEALTH PROTECTIVE TARGETS

RA1) The Air District should establish $PM_{2.5}$ concentration targets consistent with findings based on scientific evidence (e.g., an annual average of as low as 8 $\mu g/m^3$).

RA2) Advocate for U.S. EPA and the California Air Resources Board to establish more stringent air quality standards for PM.

RA3) Continue efforts to designate fine PM as a toxic air contaminant.

ADDRESS IMPACTED COMMUNITIES

RA4) Continue to develop strategic action plans for impacted communities. Ensure that these plans evaluate and choose actions based on their impact on reaching the lower air quality targets that we have recommended.

RA5) PM action plans should include best available methods that are feasible for reducing PM emissions and exposures for stationary, area, mobile, and indirect sources of PM.

RA6) Conduct community-level exposure and health impact assessments with local engagement for all highly-impacted communities.

RA7) Evaluate and strengthen implementation and enforcement of programs and rules (including Rule 11-18) to reduce exposures to $PM_{2.5}$ (including diesel PM) and ensure necessary community-specific resources to do so.

RA8) Develop strategies to consider cumulative community PM impacts in permitting processes.

RA9) Modify Air District permitting regulations to address hyper-localized hot-spot and cumulative PM health risks.

RA10) Evaluate current efforts to prevent "piecemealing" in the permitting process and take actions as needed.

RA11) Identify and further reduce significant sources of condensable PM from refineries.

RA12) Seek changes at state level to expand Air District authority for magnet sources of PM emissions.

RA13) Strengthen rules limiting emissions and trackout of road dust to reduce PM in overburdened communities.

RA14) Seek federal funding for electrification infrastructure, especially for disadvantaged communities.

ADDRESS WILDFIRES

RA15) Further develop and implement strategies including health protective measures and guidance to protect health during wildfire episodes. Such measures and guidance could include: 1) public education; 2) improved real-time monitoring and forecasting models; 3) more comprehensive research to assess short- and long-term health impacts; 4) assessment of the feasibility of strategies to reduce PM exposure in proposed forest management strategies; 5) establishment of clean air shelters (e.g., in schools, community centers, libraries, senior centers, senior living facilities) with power, HVAC/HEPA filters, personal protective equipment (PPE), etc., especially in disadvantaged communities; 6) mobile clean air shelters; and 7) strategies to provide HEPA filters for in-home high risk individuals.

REGIONAL RECOMMENDATIONS

Data:

RA16) Continue working to make air quality data for PM and PM precursors more accessible and timely. Partner with effective platforms (e.g., Purple Air).

RA17) Make current PM speciation data more available. Advocate for U.S. EPA national monitoring guidance and requirements to increase PM speciation.

RA18) Advocate for increased, broader, national monitoring, exposure, and health impact studies of UFP.

Mobile Source:

RA19) Advocate for appropriate federal and state agencies to set improved UFP filtration requirements for on-road vehicles.

RA20) Advocate for improved emission estimation and control methods for emerging source categories (e.g., tires & brakes, road dust).

RA21) Develop, fund, implement, and encourage strategies to reduce vehicle miles traveled (e.g., improved public transit; bicycle and pedestrian infrastructure, facilities, and programs; land use planning; and telework).

RA22) Support California Air Resources Board efforts to electrify trucks and other vehicles.

RA23) Assist local programs to control road dust (e.g., analyze road dust emission rates for local streets).

RA24) Seek stricter off-road mobile source rules from the California Air Resources Board.

Electrification:

RA25) Adopt a rule requiring, and create a program incentivizing, all electric utilities in new construction. Continue to look for opportunities that could include training, incentives, and programs to move our existing built environment to all electric.

RA26) Adopt rules to improve the emissions performance of water heaters and space heaters and require newly-installed heaters and other appliances to be electric.

Other:

RA27) Expand efforts to reduce emissions from commercial cooking equipment such as charbroilers and wood-fired ovens.

RA28) Consider further restrictions on residential wood burning emissions.

ANNOTATED BIBLIOGRAPHY FOR PARTICULATE MATTER REDUCTION STATEMENTS AND FRAMEWORK

PARTICULATE MATTER REDUCTION STATEMENTS

PMRS1) Particulate Matter (PM) is the most important health risk driver in Bay Area air quality, both $PM_{2.5}$ as a criteria pollutant and diesel PM as a toxic air contaminant.

Reference:

- **Bay Area Air Quality Management District: *2017 Clean Air Plan*, online at https://www.baaqmd.gov/~/media/files/planning-and-research/plans/2017-clean-air-plan/attachment-a_-proposed-final-cap-vol-1-pdf.pdf?la=en.**

  The Air District's 2017 Clean Air Plan describes strategies for reducing emissions in order to protect both public health and the environment. Health impacts of particulate matter are described in Chapter 2, "Air Pollution and Public Health." Additionally, Appendix C, "Air Pollution and Health Burden," quantifies this impact on Bay Area residents.

PMRS2) The Bay Area has made substantial progress at reducing regional $PM_{2.5}$ levels to meet current $PM_{2.5}$ standards; however, 1) more stringent standards would be more health protective; 2) exposures vary substantially across communities; and 3) wildfire smoke increases $PM_{2.5}$ levels substantially above standards.

References:

- **U.S. Environmental Protection Agency: *Air Quality Design Values, $PM_{2.5}$ Design Values, 2019,* available online at:**
  https://www.epa.gov/air-trends/air-quality-design-values
  https://www.epa.gov/sites/production/files/2020-05/pm25_designvalues_2017_2019_final_05_26_20.xlsx

  Each year, the U.S. EPA calculates and publishes design values for each criteria pollutant for all the State, Local, and Tribal air monitoring sites in the country. Since the design values can change after the date of publication for a variety of reasons, the information in the design value tables is intended for informational use only and does not constitute a regulatory determination by U.S. EPA as whether an area has attained a NAAQS. This document shows that the 2017-2019 annual $PM_{2.5}$ design values are below the Annual $PM_{2.5}$ NAAQS at every site in the Bay Area.

- ***Bay Area Air Quality Management District: Preliminary Analysis of $PM_{2.5}$ Values With and Without Wildfire Smoke Episodes in 2017 and 2018*, available online at https://www.baaqmd.gov/~/media/files/technical-services/pm-2-5-design-values-re-wildfires/wildfire_pm_impacts_20201006-pdf.pdf?la=en.**

  This document describes the analyses performed by the Bay Area Air Quality Management District to estimate the $PM_{2.5}$ design values without days in 2017 and 2018 impacted by wildfire smoke. This preliminary analysis provides a rough evaluation of how the $PM_{2.5}$ trends would be different without the impact of a few of the largest most recent wildfires. As shown in this document, when days impacted by wildfire are excluded, the 2017-2019 $PM_{2.5}$ design values are below the applicable standards.

- **Bay Area Air Quality Management District: *West Oakland Community Action Plan: Owning Our Air*, online at https://www.baaqmd.gov/community-health/community-health-protection-program/west-oakland-community-action-plan.**

  This plan, shaped by a community-based steering committee, identifies specific air quality challenges in different parts of West Oakland and outlines strategies for reducing local residents' PM exposures. Chapter 5 presents a Technical Assessment that estimates the relative contributions of local and regional sources to PM concentrations, finding that proximity to local sources of PM emissions can substantially elevate exposure levels.

- **Colmer, J., Hardman, I., Shimshack, J. and Voorheis, J., 2020. "Disparities in $PM_{2.5}$ air pollution in the United States." *Science*, 369(6503), 575-578.**

  This study combined 36 years of data across approximately 65,000 census tracts to understand disparities in $PM_{2.5}$ concentration levels. The authors found that, although both overall $PM_{2.5}$ concentration levels and differences between the most and least polluted areas have decreased, disparities in $PM_{2.5}$ concentration levels persist. More-polluted areas did not experience greater relative reductions; rather, proportional decreases have been consistent across vigintiles. The most polluted areas of 1981 remained the most polluted areas of 2016.

- **Environmental Protection Agency: *PM Integrated Science Assessment*, online at https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter, Section 13.3, 13-69 (p. 1902).**

  The U.S. Environmental Protection Agency's 2019 *Integrated Science Assessment for Particulate Matter* reviewed the body of new particulate matter research since 2009 including epidemiological studies, animal toxicological studies, and controlled human exposure studies at PM levels analogous to ambient concentrations in U.S. communities.

  Section 13.3 discusses the relationship of $PM_{2.5}$ to climate. With respect to wildfires, the *Integrated Science Assessment* describes a feedback loop in which warmer temperatures and land use change lead to more frequent wildfires, which in turn can affect precipitation patterns in ways that further increase the likelihood of fires.

- **Wettstein, Zachary S, Sumi Hoshiko, Jahan Fahimi, Robert J Harrison, Wayne E Cascio, and Ana G Rappold. 2018. "Cardiovascular and Cerebrovascular Emergency Department Visits Associated with Wildfire Smoke Exposure in California in 2015." *Journal of the American Heart Association* 7 (8). Am Heart Assoc: e007492.**

  This study examined patterns in hospital emergency department visits in the days following wildfire events across much of California, finding an increased likelihood of cardiovascular and cerebrovascular (stroke) events following nearby wildfires among people over the age of 65, particularly those with underlying cardiovascular conditions.

- **Jones, C.G., Rappold, A.G., Vargo, J., Cascio, W.E., Kharrazi, M., McNally, B., and Hoshiko, S., 2020. "Out-of-Hospital Cardiac Arrests and Wildfire-Related Particulate Matter During 2015–2017 California Wildfires." *Journal of the American Heart Association*, 9(8), p.e014125.**

  This study examined the frequency of cardiac arrests occurring outside a medical setting (e.g. at home, work, or in a public place) in the days following wildfire events in 14 California counties. The authors found that men and women aged 35 or older were more likely to experience sudden cardiac arrest (heart attack) on days with heavy smoke, with risks appearing further elevated for people in lower income groups.

- **Environmental Protection Agency: *PM Integrated Science Assessment*, online at https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter, Section 1.4.1.5, 1-30 (p. 166).**

  The U.S. Environmental Protection Agency's 2019 *Integrated Science Assessment for Particulate Matter* reviewed the body of new particulate matter research since 2009 including epidemiological studies, animal toxicological studies, and controlled human exposure studies at PM levels analogous to ambient concentrations in U.S. communities.

  Section 1.4.1.5 describes how the available evidence supports the conclusion that there is a causal relationship between ambient $PM_{2.5}$ exposure and mortality.

- **Environmental Protection Agency: *Policy Assessment for PM NAAQS* 1/2020, online at https://www.epa.gov/naaqs/particulate-matter-pm-standards-policy-assessments-current-review-0, Section 3.3.2.2, Table 3-7, 3-90 (p. 190) and Table 3-8, 3-91 (p. 191); Section 3.3.3, 3-97 (p. 197).**

  The U.S. Environmental Protection Agency's *Policy Assessment for Review of the PM NAAQS* is intended to serve as a bridge between science and rulemaking, interpreting the findings of the U.S. EPA *Integrated Science Assessment* with respect to existing and potential policy.

  Section 3.3.2.2., Table 3-7 compares mortality associated with $PM_{2.5}$ exposure at the current 12 μg/m^3 standard with mortality risk at potential standards of 9 μg/m^3, 10 μg/m^3, and 11 μg/m^3, and Table 3-8 calculates the number of lives that could be spared and the potential percent reduction in mortality at these lower $PM_{2.5}$ concentrations.

Section 3.3.3. summarizes the document's conclusions, stating that "the current primary $PM_{2.5}$ standards could allow a substantial number of $PM_{2.5}$-associated deaths in the U.S."

- **Xiao Wu, Danielle Braun, Marianthi-Anna Kioumourtzoglou, Francesca Dominici. "Evaluating the Impact of Long-term Exposure to Fine Particulate Matter on Mortality Among the Elderly."** ***Science Advances*****, 2020 DOI: 10.1126/sciadv.aba5692.**

  Using 16 years of data for more than 68.5 million people, this study provides strong evidence of a causal link between long-term exposure to $PM_{2.5}$ concentrations below the current NAAQS and mortality. The authors estimate that an annual standard of 10 μg/m^3 would save more than 143,000 lives in one decade compared to the current 12μg/m^3 standard.

- **Di, Q., Wang, Y., Zanobetti, A., Wang, Y., Koutrakis, P., Choirat, C., Dominici, F. and Schwartz, J.D. (2017). "Air pollution and mortality in the Medicare population."** ***New England Journal of Medicine*****, 376(26), 2513-2522.**

  This large-scale analysis used data from the entire U.S. population over the age of 65 — approximately 61 million people — to investigate associations between mortality and exposure to ambient $PM_{2.5}$ levels as measured by U.S. EPA data, concluding that risk of death rose significantly with $PM_{2.5}$ levels at concentrations below the 12 μg/m^3 NAAQS threshold.

PMRS3) The current particulate matter national ambient air quality standards (NAAQS) are not health protective.

The Advisory Council concurs with the following statement: "Based on scientific evidence, as detailed in Attachment B [of our letter], the [Independent Particulate Matter Review Panel] finds that the current suite of primary fine particle ($PM_{2.5}$) annual and 24-hour standards are not protective of public health. Both of these standards should be revised to new levels, while retaining their current indicators, averaging times, and forms. The annual standard should be revised to a range of 10 μg/m^3 to 8 μg/m^3. The 24-hour standard should be revised to a range of 30 μg/m^3 to 25 μg/m^3. These scientific findings are based on consistent epidemiological evidence from multiple multi-city studies, augmented with evidence from single-city studies, at policy-relevant ambient concentrations in areas with design values at and below the levels of the current standards, and are supported by research from experimental models in animals and humans and by accountability studies." (Independent Particulate Review Panel Letter on Draft EPA PM Policy Assessment, October 2019).

References:

- **Independent Particulate Matter Review Panel:** ***Final letter to Administrator Wheeler with the IPMRP's recommendations*****, October 22, 2019. Available online at https://www.ucsusa.org/meeting-independent-particulate-matter-review-panel**

  This letter, written by the scientists who made up the U.S. EPA's Clean Air Scientific Advisory Committee (CASAC) before it was dismissed without notice in 2018, contains these experts' findings after reviewing the EPA's Integrated Science Assessment (ISA, Reference 2) and Policy Assessment (PA, Reference 3) regarding particulate matter. The panel strongly called for stricter PM standards based on the evidence in the ISA and PA.

- **Environmental Protection Agency:** ***PM Integrated Science Assessment*****, online at https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter, Section 1.4.1.5, 1-30 (p. 166); Section 1.5.3, 1-48 (p. 184); Section 11.1.10, 11-38 (p. 1651) and Section 11.2.4, 11-84 (p. 1697).**

  The U.S. Environmental Protection Agency's 2019 *Integrated Science Assessment for Particulate Matter* reviewed the body of new particulate matter research since 2009 including epidemiological studies, animal toxicological studies, and controlled human exposure studies at PM levels analogous to ambient concentrations in U.S. communities.

  This review demonstrated that PM causes more health problems than previously known, at lower concentrations than previously known, and disproportionately affects vulnerable populations.

  Section 1.4.1.5 describes how the available evidence supports the conclusion that there is a causal relationship between ambient $PM_{2.5}$ exposure and mortality.

  Section 1.5.3 explains the concentration-response relationship observed between $PM_{2.5}$ exposure and health effects, stating that recent studies "continue to provide evidence of a linear, no-threshold relationship between both short- and long-term $PM_{2.5}$ exposure and several respiratory and cardiovascular effects, and mortality."

  Sections 11.1.10 (short-term exposure) and 11.2.4 (long-term exposure) provide further discussion of this concentration-response relationship, evidence regarding its linearity, and the lack of a $PM_{2.5}$ threshold below which deleterious health effects are not observed.

- **Environmental Protection Agency:** ***Policy Assessment for PM NAAQS*** **1/2020, online at https://www.epa.gov/naaqs/particulate-matter-pm-standards-policy-assessments-current-review-0, Section 3.3.2.2, Table 3-7, 3-90 (p. 190) and Table 3-8, 3-91 (p. 191); Section 3.3.3, 3-97 (p. 197).**

  The U.S. Environmental Protection Agency's *Policy Assessment for Review of the PM NAAQS* is intended to serve as a bridge between science and rulemaking, interpreting the findings of the U.S. EPA *Integrated Science Assessment* with respect to existing and potential policy.

In Section 3.3.2.2., Table 3-7 compares mortality associated with $PM_{2.5}$ exposure at the current 12 µg/m^3 standard with mortality risk at potential standards of 9 µg/m^3, 10 µg/m^3, and 11 µg/m^3, and Table 3-8 calculates the number of lives that could be spared and the potential percent reduction in mortality at these lower $PM_{2.5}$ concentrations.

Section 3.3.3. summarizes the document's conclusions, stating that "the current primary $PM_{2.5}$ standards could allow a substantial number of $PM_{2.5}$-associated deaths in the U.S."

PMRS4) More stringent standards to reduce exposures are urgently needed, and, if met, would save thousands of lives in the U.S. and many Bay Area lives each year.

Reference:

- **Environmental Protection Agency: *Policy Assessment for PM NAAQS* 1/2020, online at https://www.epa.gov/naaqs/particulate-matter-pm-standards-policy-assessments-current-review-0, Section 3.3.2.2, Table 3-7, 3-90 (p. 190) and Table 3-8, 3-91 (p. 191); Section 3.3.3, 3-97 (p. 197).**

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  Section 3.3.3. summarizes the document's conclusions, stating that "the current primary $PM_{2.5}$ standards could allow a substantial number of $PM_{2.5}$-associated deaths in the U.S."

PMRS5) There is no known threshold for harmful $PM_{2.5}$ health effects; thus, it follows that additional reductions of $PM_{2.5}$ concentrations will achieve additional public health benefits.

Reference:

- **Environmental Protection Agency: *PM Integrated Science Assessment*, online at https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter, Section 1.5.3, 1-48 (p. 184); Section 11.1.10, 11-38 (p. 1651) and Section 11.2.4, 11-84 (p. 1697).**

  The U.S. Environmental Protection Agency's 2019 *Integrated Science Assessment for Particulate Matter* reviewed the body of new particulate matter research since 2009 including epidemiological studies, animal toxicological studies, and controlled human exposure studies at PM levels analogous to ambient concentrations in U.S. communities.

Section 1.5.3 explains the concentration-response relationship observed between $PM_{2.5}$ exposure and health effects, stating that recent studies "continue to provide evidence of a linear, no-threshold relationship between both short- and long-term $PM_{2.5}$ exposure and several respiratory and cardiovascular effects, and mortality.

Sections 11.1.10 (short-term exposure) and 11.2.4 (long-term exposure) provide further discussion of this concentration-response relationship, evidence regarding its linearity, and the lack of a $PM_{2.5}$ threshold below which deleterious health effects are not observed.

PMRS6) An Air District guideline "target" below the current $PM_{2.5}$ NAAQS is warranted to protect public health; if the Air District were to set that target at an annual average of as low as 8 µg/m^3, U.S. EPA's $PM_{2.5}$ NAAQS risk assessment provides scientific evidence that annual average targets in that range would save additional lives.

References:

- **Environmental Protection Agency: *PM Integrated Science Assessment*, online at https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter, Section 1.4.1.5, 1-30 (p. 166).**

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- **Environmental Protection Agency: *Policy Assessment for PM NAAQS* 1/2020, online at https://www.epa.gov/naaqs/particulate-matter-pm-standards-policy-assessments-current-review-0, Section 3.3.2.2, Table 3-7, 3-90 (p. 190) and Table 3-8, 3-91 (p. 191); Section 3.3.3, 3-97 (p. 197).**

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- **Xiao Wu, Danielle Braun, Marianthi-Anna Kioumourtzoglou, Francesca Dominici. "Evaluating the Impact of Long-term Exposure to Fine Particulate Matter on Mortality Among the Elderly." *Science Advances*, 2020 DOI: 10.1126/sciadv.aba5692.**

  Using 16 years of data for more than 68.5 million people, this study provides strong evidence of a causal link between long-term exposure to $PM_{2.5}$ concentrations below the current NAAQS and mortality. The authors estimate that an annual standard of 10 µg/m^3 would save more than 143,000 lives in one decade compared to the current 12µg/m^3 standard.

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  This large-scale analysis used data from the entire U.S. population over the age of 65 — approximately 61 million people — to investigate associations between mortality and exposure to ambient $PM_{2.5}$ levels as measured by U.S. EPA data, concluding that risk of death rose significantly with $PM_{2.5}$ levels at concentrations below the 12 µg/m^3 NAAQS threshold.

PMRS7) Although a large fraction of $PM_{2.5}$ is regionally contributed, substantially elevated $PM_{2.5}$ exposures can occur in locations adjacent to local PM sources. Therefore, controlling emissions in these local impacted areas is of primary importance.

References:

- **Bay Area Air Quality Management District: *West Oakland Community Action Plan: Owning Our Air*, online at https://www.baaqmd.gov/community-health/community-health-protection-program/west-oakland-community-action-plan.**

  This plan, shaped by a community-based steering committee, identifies specific air quality challenges in different parts of West Oakland and outlines strategies for reducing local residents' PM exposures. Chapter 5 presents a Technical Assessment that estimates the relative contributions of local and regional sources to PM concentrations, finding that proximity to local sources of PM emissions can substantially elevate exposure levels.

- **Colmer, J., Hardman, I., Shimshack, J. and Voorheis, J., 2020. "Disparities in $PM_{2.5}$ air pollution in the United States." *Science*, 369(6503), 575-578.**

  This study combined 36 years of data across approximately 65,000 census tracts to understand disparities in $PM_{2.5}$ concentration levels. The authors found that, although both overall $PM_{2.5}$ concentration levels and differences between the most and least polluted areas have decreased, disparities in $PM_{2.5}$ concentration levels persist. More-polluted areas did not experience greater relative reductions; rather, proportional decreases have been consistent across vigintiles. The most polluted areas of 1981 remained the most polluted areas of 2016.

PMRS8) Wildfire PM is a serious contributor to PM health effects; early health studies are of concern; more research on acute and sub-chronic effects is ongoing and urgently needed. Wildfire PM exposure is projected to increase in duration and intensity, due to climate change, and this justifies greater efforts to reduce controllable sources of PM to reduce overall health risk.

References:

- **Environmental Protection Agency: *PM Integrated Science Assessment*, online at https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter, Section 13.3, 13-69 (p. 1902).**

  The U.S. Environmental Protection Agency's 2019 *Integrated Science Assessment for Particulate Matter* reviewed the body of new particulate matter research since 2009 including epidemiological studies, animal toxicological studies, and controlled human exposure studies at PM levels analogous to ambient concentrations in U.S. communities.

  Section 13.3 discusses the relationship of $PM_{2.5}$ to climate. With respect to wildfires, the *Integrated Science Assessment* describes a feedback loop in which warmer temperatures and land use change lead to more frequent wildfires, which in turn can affect precipitation patterns in ways that further increase the likelihood of fires.

- **Environmental Protection Agency: *Memorandum on Modeling Guidance for Demonstrating Air Quality Goals for Ozone, PM2.5, and Regional Haze, 2018*, available online at https://www3.epa.gov/ttn/scram/guidance/guide/O3-PM-RH-Modeling_Guidance-2018.pdf**

  This U.S. EPA document provides modeling guidance for air quality agencies charged with satisfying federal demonstration requirements. Guidance regarding calculation of PM design values acknowledges: "it is well-established that inter-annual variability in meteorological conditions often leads to year to year differences in design values, even with static emissions levels" (p. 101).

- **Wettstein, Zachary S, Sumi Hoshiko, Jahan Fahimi, Robert J Harrison, Wayne E Cascio, and Ana G Rappold. 2018. "Cardiovascular and Cerebrovascular Emergency Department Visits Associated with Wildfire Smoke Exposure in California in 2015." *Journal of the American Heart Association* 7 (8). Am Heart Assoc: e007492.**

  This study examined patterns in hospital emergency department visits in the days following wildfire events across much of California, finding an increased likelihood of cardiovascular and cerebrovascular (stroke) events following nearby wildfires among people over the age of 65, particularly those with underlying cardiovascular conditions.

- **Jones, C.G., Rappold, A.G., Vargo, J., Cascio, W.E., Kharrazi, M., McNally, B., and Hoshiko, S., 2020. "Out-of-Hospital Cardiac Arrests and Wildfire-Related Particulate Matter During 2015–2017 California Wildfires."** ***Journal of the American Heart Association*****, 9(8), p.e014125.**

  This study examined the frequency of cardiac arrests occurring outside a medical setting (e.g. at home, work, or in a public place) in the days following wildfire events in 14 California counties. The authors found that men and women aged 35 or older were more likely to experience sudden cardiac arrest (heart attack) on days with heavy smoke, with risks appearing further elevated for people in lower income groups.

PMRS9) Some species of PM may be more dangerous than others; as yet, no PM species can be exonerated.

Reference:

- **Environmental Protection Agency:** ***PM Integrated Science Assessment*****, online at https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter, Section 1.5.4, 1-50 (p. 186).**

  The U.S. Environmental Protection Agency's 2019 Integrated Science Assessment for Particulate Matter reviewed the body of new particulate matter research since 2009 including epidemiological studies, animal toxicological studies, and controlled human exposure studies at PM levels analogous to ambient concentrations in U.S. communities.

  Section 1.5.4, within Section 1.5 "Policy Considerations," reviews the evidence regarding health effects of specific components or sources of PM, such as motor vehicle emissions, coal combustion, and vegetative burning. The authors conclude that the current state of the science does not clearly differentiate health effects resulting from exposure to different components or sources of PM; "the evidence does not indicate that any one source or component is consistently more strongly related with health effects than $PM_{2.5}$ mass."

- **Achilleos, S., Kioumourtzoglou, M.-A., Wu, C.-D., Schwartz, J.D., Koutrakis, P., Papatheodorou, S.I., 2017. "Acute effects of fine particulate matter constituents on mortality: A systematic review and meta-regression analysis."** ***Environment International*** **109, 89–100.**

  This meta-analysis combined data from all relevant studies investigating links between $PM_{2.5}$ particle constituents and mortality through July 2015 (a total of 41 studies covering 142 cities in several world regions). The authors found evidence that exposure to the combustion elements of elemental carbon (EC) and potassium (K), generally recognized as traffic and wood combustion elements respectively, are each associated with increased risk of mortality. They also observed that health effects varied by region.

- **Yang, Y., Ruan, Z., Wang, X., Yang, Y., Mason, T.G., Lin, H., Tian, L., 2019. "Short-term and long-term exposures to fine particulate matter constituents and health: A systematic review and meta-analysis."** ***Environmental Pollution*** **247, 874–882.**

  This meta-analysis reviewed all relevant studies through August 2018 examining mortality and morbidity in relation to exposure to different components of PM. The authors found consistent associations between cardiovascular morbidity and mortality and exposure to black carbon and organic carbon (associated with a range of combustion including motor vehicle emissions and biomass burning). They also found likely associations between cardiovascular health effects and exposure to $PM_{2.5}$ nitrate, sulfate, zinc, silicon, iron, nickel, vanadium, and potassium; and likely associations between respiratory health effects and exposure to $PM_{2.5}$ nitrate, sulfate, and vanadium.

PMRS10) Ultrafine particles (UFP), which are present in the air in large numbers, pose a health risk, but are not adequately monitored. They generally enter the body through the upper and lower respiratory tract and can translocate to essentially all organs. Compared to fine particles ($PM_{2.5}$), they cause more pulmonary inflammation per unit mass, and are retained longer in the lung.

Reference:

- **Environmental Protection Agency:** ***PM Integrated Science Assessment*****, online at https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter, Section 5.5.1, 5-279 (p. 843); Section 5.5.1.1, 5-281, (p.844); Section 5.5.2.3, 5-287 (p. 851)**

  The U.S. Environmental Protection Agency's 2019 Integrated Science Assessment for Particulate Matter reviewed the body of new particulate matter research since 2009 including epidemiological studies, animal toxicological studies, and controlled human exposure studies at PM levels analogous to ambient concentrations in U.S. communities.

  Section 5.5.1 on "Biological Plausibility" describes the biological pathways by which exposure to ultrafine particles (UFP) is understood to affect human health — potentially activating not only respiratory distress but also a range of immune, nervous system, and other reactions, including oxidative stress.

  Section 5.5.1.1 describes the current science with respect to UFP exposure and respiratory injury, inflammation, and oxidative stress. Evidence suggests that short-term exposure to UFP is associated with markers of injury, inflammatory response, oxidative stress, and allergic asthma, which is consistent with epidemiologic evidence linking UFP exposure with asthma-related hospital admissions.

  Section 5.5.2.3 further investigates the connection between UFP and asthma, reviewing conclusions from the 2009 ISA as well as a more recent animal toxicological study. That study, conducted using mice, indicates that UFP penetrates into the deep lung and is associated with allergic inflammation, asthma exacerbation, and oxidative stress.

- **Ohlwein, S., Kappeler, R., Joss, M.K., Künzli, N., Hoffmann, B., 2019. "Health effects of ultrafine particles: A systematic literature review update of epidemiological evidence."** ***International Journal of Public Health*** **64, 547–559.**

  This meta-analysis reviewed 85 recent studies (published 2011 through 2017) of the health effects of ultrafine particles (UFP) in ambient air pollution. The authors found some evidence for increased risk of short-term inflammatory and cardiovascular effects with UFP exposure beyond the expected effects of larger categories of PM.

F1) The Air District should move as quickly as possible to take maximal feasible action within its authority to reduce emissions from PM sources, prioritizing the most impacted areas.

Reference:

- **No citation needed.**

F2) PM reduction strategies should prioritize those measures that are most effective in reducing exposure and improving public health and health equity in the most impacted areas.

Reference:

- **Environmental Protection Agency: *Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements; Final Rule*, online at https://www.govinfo.gov/content/pkg/FR-2016-08-24/pdf/2016-18768.pdf.**

  This U.S. EPA document describes requirements to be met in implementing National Ambient Air Quality Standards for $PM_{2.5}$. Section G, "Measures to Ensure Appropriate Protections for Overburdened Populations," articulates the importance of protecting communities whose health is disproportionately impacted by $PM_{2.5}$ exposure.

F3) Local strategies should account for the fact that the most effective exposure reduction measures may differ across communities, due to varying source mix and size, ambient PM concentration levels, physical circumstances (e.g., meteorology, terrain), and other relevant factors.

Reference:

- **California Air Resources Board: *Community Air Protection Blueprint*, online at https://ww2.arb.ca.gov/capp-blueprint.**

  This state-level document outlines the process for meeting the requirements of California's AB 617 legislation mandating a statewide program to address long-standing air pollution concerns in disadvantaged communities. Designed to address the "unique needs of individual communities" (p. 7), the Blueprint calls for the development of community-specific action plans based on highly localized emissions, exposure, and public health data and guided by steering committees comprising local community members.

F4) The Air District should focus PM reduction in areas with elevated exposures, health vulnerability, and those areas with increased impacts and sensitive populations (e.g., U.S. EPA identifies children, non-white, low socioeconomic status, elderly).

Reference:

- **Environmental Protection Agency: *PM Integrated Science Assessment*, online at https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter, Section 1.5.5, 1-53 through 1-55 (p. 189-191).**

  The U.S. Environmental Protection Agency's 2019 *Integrated Science Assessment for Particulate Matter* reviewed the body of new particulate matter research since 2009 including epidemiological studies, animal toxicological studies, and controlled human exposure studies at PM levels analogous to ambient concentrations in U.S. communities.

  Section 1.5.5 examines evidence concerning differences in health risk from PM exposure among specific sub-populations. Evidence is sufficient to demonstrate that children and nonwhite people are at greater risk of experiencing $PM_{2.5}$ health effects. The evidence also suggests that people with pre-existing health conditions and low socioeconomic status are at increased risk.

F5) PM reduction strategies for highly-impacted communities must include control of the cumulative impact of regional (Bay Area-wide), local (community-level), and localized hot-spot (block-level) sources.

Reference:

- **State of California: AB-617 Nonvehicular air pollution: criteria air pollutants and toxic air contaminants, online at https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB617.**

  This state legislation mandates a statewide program to address long-standing air pollution concerns in disadvantaged communities. California air districts in which such communities are identified are tasked with designing and deploying community-level monitoring programs and exposure reduction strategies.

F6) PM reduction strategies should include emission reduction measures for both primary PM and secondary PM formed in the air (e.g., emissions of precursor ROG, NOx, NH_3, and SO_2).

Reference:

- **Environmental Protection Agency: Our Nation's Air (2020), online at https://gispub.epa.gov/air/trendsreport/2020.**

  This annual report from the U.S. EPA summarizes trends in air quality. In the section titled "Understanding $PM_{2.5}$ Composition Helps Reduce Fine Particle Pollution," the agency emphasizes the importance of tracking the components of secondary PM.

F7) PM reduction strategies will need to address multiple source categories with a wide range of emission reduction measures, and may vary with location; there are no single, universal solutions.

Reference:

- **Environmental Protection Agency: *Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements; Final Rule*, online at https://www.govinfo.gov/content/pkg/FR-2016-08-24/pdf/2016-18768.pdf.**

  This U.S. EPA document describes requirements to be met in implementing National Ambient Air Quality Standards for $PM_{2.5}$. The agency specifies that these rules and regulations apply to "numerous and diverse sources" of harmful emissions (Section B.1, p. 58012).

Particulate Matter:

Spotlight on Health Protection

Appendix A: Annotated Bibliography for Particulate Matter Reduction Statements and Framework

APPENDIX A: ANNOTATED BIBLIOGRAPHY FOR PARTICULATE MATTER REDUCTION STATEMENTS AND FRAMEWORK *(TABLE)*

The annotated bibliography provides scientific reference and informational materials to support the Advisory Council's particulate matter reduction statements and framework for evaluation. These references are also provided within the report.

ID	*PARTICULATE MATTER REDUCTION STATEMENT*	*CITATION #*
PMRS1	Particulate Matter (PM) is the most important health risk driver in Bay Area air quality, both $PM_{2.5}$ as a criteria pollutant and diesel PM as a toxic air contaminant.	1
PMRS2	The Bay Area has made substantial progress at reducing regional $PM_{2.5}$ levels to meet current $PM_{2.5}$ standards; however, 1) more stringent standards would be more health protective; 2) exposures vary substantially across communities; and 3) wildfire smoke increases $PM_{2.5}$ levels substantially above standards.	4 5 9 10 2 e 11 12 2 a 3 a, b 6 7
PMRS3	The current particulate matter national ambient air quality standards (NAAQS) are not health protective. *The Advisory Council concurs with the following statement: "Based on scientific evidence, as detailed in Attachment B [of our letter], the [Independent Particulate Matter Review Panel] finds that the current suite of primary fine particle ($PM_{2.5}$) annual and 24-hour standards are not protective of public health. Both of these standards should be revised to new levels, while retaining their current indicators, averaging times, and forms. The annual standard should be revised to a range of 10 µg/m³ to 8 µg/m³. The 24-hour standard should be revised to a range of 30 µg/m³ to 25 µg/m³. These scientific findings are based on consistent epidemiological evidence from multiple multi-city studies, augmented with evidence from single-city studies, at policy-relevant ambient concentrations in areas with design values at and below the levels of the current standards, and are supported by research from experimental models in animals and humans and by accountability studies." (Independent Particulate Review Panel Letter on Draft EPA PM Policy Assessment, October 2019).*	2 a, b, d 3 a, b 20

ID	*PARTICULATE MATTER REDUCTION STATEMENT*	*CITATION #*
PMRS4	More stringent standards to reduce exposures are urgently needed, and, if met, would save thousands of lives in the U.S. and many Bay Area lives each year.	3 a, b
PMRS5	There is no known threshold for harmful $PM_{2.5}$ health effects; thus, it follows that additional reductions of $PM_{2.5}$ concentrations will achieve additional public health benefits.	2 b, d
PMRS6	An Air District guideline "target" below the current $PM_{2.5}$ NAAQS is warranted to protect public health; if the Air District were to set that target at an annual average of as low as 8 $\mu g/m^3$, U.S. EPA's $PM_{2.5}$ NAAQS risk assessment provides scientific evidence that annual average targets in that range would save additional lives.	2 a 3 a, b 6 7
PMRS7	Although a large fraction of $PM_{2.5}$ is regionally contributed, substantially elevated $PM_{2.5}$ exposures can occur in locations adjacent to local PM sources. Therefore, controlling emissions in these local impacted areas is of primary importance.	9 10
PMRS8	Wildfire PM is a serious contributor to PM health effects; early health studies are of concern; more research on acute and sub-chronic effects is ongoing and urgently needed. Wildfire PM exposure is projected to increase in duration and intensity, due to climate change, and this justifies greater efforts to reduce controllable sources of PM to reduce overall health risk.	2 e 8 11 12
PMRS9	Some species of PM may be more dangerous than others; as yet, no PM species can be exonerated	2f 17 18
PMRS10	Ultrafine particles (UFP), which are present in the air in large numbers, pose a health risk, but are not adequately monitored. They generally enter the body through the upper and lower respiratory tract and can translocate to essentially all organs. Compared to fine particles ($PM_{2.5}$), they cause more pulmonary inflammation per unit mass, and are retained longer in the lung.	2 g, h, i 19

ID	FRAMEWORK FOR EVALUATING PARTICULATE MATTER REDUCTION STRATEGIES	CITATION #
F1	The Air District should move as quickly as possible to take maximal feasible action within its authority to reduce emissions from PM sources, prioritizing the most impacted areas.	n.a.
F2	PM reduction strategies should prioritize those measures that are most effective in reducing exposure and improving public health and health equity in the most impacted areas.	16 b
F3	Local strategies should account for the fact that the most effective exposure reduction measures may differ across communities, due to varying source mix and size, ambient PM concentration levels, physical circumstances (e.g., meteorology, terrain), and other relevant factors.	13
F4	The Air District should focus PM reduction in areas with elevated exposures, health vulnerability, and those areas with increased impacts and sensitive populations (e.g., U.S. EPA identifies children, non-white, low socioeconomic status, elderly).	2 c
F5	PM reduction strategies for highly-impacted communities must include control of the cumulative impact of regional (Bay Area-wide), local (community-level), and localized hot-spot (block-level) sources.	14
F6	PM reduction strategies should include emission reduction measures for both primary PM and secondary PM formed in the air (e.g., emissions of precursor ROG, NO_x, NH_3, and SO_2).	15
F7	PM reduction strategies will need to address multiple source categories with a wide range of emission reduction measures, and may vary with location; there are no single, universal solutions.	16 a

REFERENCES

1. **Bay Area Air Quality Management District: *2017 Clean Air Plan*, online at https://www.baaqmd.gov/~/media/files/planning-and-research/plans/2017-clean-air-plan/attachment-a_-proposed-final-cap-vol-1-pdf.pdf?la=en**

   The Air District's 2017 Clean Air Plan describes strategies for reducing emissions in order to protect both public health and the environment. Health impacts of particulate matter are described in Chapter 2, "Air Pollution and Public Health." Additionally, Appendix C, "Air Pollution and Health Burden," quantifies this impact on Bay Area residents.

2. **Environmental Protection Agency: *PM Integrated Science Assessment*, online at https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter**

   a. Section 1.4.1.5, 1-30 (p. 166)
   b. Section 1.5.3, 1-48 (p. 184)
   c. Section 1.5.5, 1-53 through 1-55 (p. 189-191)
   d. Section 11.1.10, 11-38 (p. 1651) and Section 11.2.4, 11-84 (p. 1697)
   e. Section 13.3, 13-69 (p. 1902)
   f. Section 1.5.4, 1-50 (p. 186)
   g. Section 5.5.1, 5-279 (p. 843)
   h. Section 5.5.1.1, 5-281, (p. 844)
   i. Section 5.5.2.3, 5-287 (p. 851)

   The U.S. Environmental Protection Agency's 2019 *Integrated Science Assessment for Particulate Matter* reviewed the body of new particulate matter research since 2009 including epidemiological studies, animal toxicological studies, and controlled human exposure studies at PM levels analogous to ambient concentrations in U.S. communities.

   This review demonstrated that PM causes more health problems than previously known, at lower concentrations than previously known, and disproportionately affects vulnerable populations.

   (a) Section 1.4.1.5 describes how the available evidence supports the conclusion that there is a causal relationship between ambient $PM_{2.5}$ exposure and mortality.

   (b) Section 1.5.3 explains the concentration-response relationship observed between $PM_{2.5}$ exposure and health effects, stating that recent studies "continue to provide evidence of a linear, no-threshold relationship between both short- and long-term $PM_{2.5}$ exposure and several respiratory and cardiovascular effects, and mortality."

(c) Section 1.5.5 examines evidence concerning differences in health risk from PM exposure among specific sub-populations. Evidence is sufficient to demonstrate that children and nonwhite people are at greater risk of experiencing $PM_{2.5}$ health effects. The evidence also suggests that people with pre-existing health conditions and low socioeconomic status are at increased risk.

(d) Sections 11.1.10 (short-term exposure) and 11.2.4 (long-term exposure) provide further discussion of this concentration-response relationship, evidence regarding its linearity, and the lack of a $PM_{2.5}$ threshold below which deleterious health effects are not observed.

(e) Section 13.3 discusses the relationship of $PM_{2.5}$ to climate. With respect to wildfires, the *Integrated Science Assessment* describes a feedback loop in which warmer temperatures and land use change lead to more frequent wildfires, which in turn can affect precipitation patterns in ways that further increase the likelihood of fires.

(f) Section 1.5.4, within Section 1.5 "Policy Considerations," reviews the evidence regarding health effects of specific components or sources of PM, such as motor vehicle emissions, coal combustion, and vegetative burning. The authors conclude that the current state of the science does not clearly differentiate health effects resulting from exposure to different components or sources of PM; "the evidence does not indicate that any one source or component is consistently more strongly related with health effects than PM2.5 mass."

(g) Section 5.5.1 on "Biological Plausibility" describes the biological pathways by which exposure to ultrafine particles (UFP) is understood to affect human health — potentially activating not only respiratory distress but also a range of immune, nervous system, and other reactions, including oxidative stress.

(h) Section 5.5.1.1 describes the current science with respect to UFP exposure and respiratory injury, inflammation, and oxidative stress. Evidence suggests that short-term exposure to UFP is associated with markers of injury, inflammatory response, oxidative stress, and allergic asthma, which is consistent with epidemiologic evidence linking UFP exposure with asthma-related hospital admissions.

(i) Section 5.5.2.3 further investigates the connection between UFP and asthma, reviewing conclusions from the 2009 ISA as well as a more recent animal toxicological study. That study, conducted using mice, indicates that UFP penetrates into the deep lung and is associated with allergic inflammation, asthma exacerbation, and oxidative stress.

3. **Environmental Protection Agency: *Policy Assessment for PM NAAQS* 1/2020, online at https://www.epa.gov/naaqs/particulate-matter-pm-standards-policy-assessments-current-review-0**

    a. Section 3.3.2.2, Table 3-7, 3-90 (p. 190) and Table 3-8, 3-91 (p. 191)
    b. Section 3.3.3, 3-97 (p. 197)

    The U.S. Environmental Protection Agency's *Policy Assessment for Review of the PM NAAQS* is intended to serve as a bridge between science and rulemaking, interpreting the findings of the U.S. EPA *Integrated Science Assessment* with respect to existing and potential policy.

    (a) In Section 3.3.2.2., Table 3-7 compares mortality associated with $PM_{2.5}$ exposure at the current 12 μg/m^3 standard with mortality risk at potential standards of 9 μg/m^3, 10 μg/m^3, and 11 μg/m^3, and Table 3-8 calculates the number of lives that could be spared and the potential percent reduction in mortality at these lower $PM_{2.5}$ concentrations.
    (b) Section 3.3.3 summarizes the document's conclusions, stating that "the current primary $PM_{2.5}$ standards could allow a substantial number of $PM_{2.5}$-associated deaths in the U.S."

4. **U.S. Environmental Protection Agency: *Air Quality Design Values, $PM_{2.5}$ Design Values, 2019,* available online at:**
    https://www.epa.gov/air-trends/air-quality-design-values
    https://www.epa.gov/sites/production/files/2020-05/pm25_designvalues_2017_2019_final_05_26_20.xlsx

    Each year, the U.S. EPA calculates and publishes design values for each criteria pollutant for all the State, Local, and Tribal air monitoring sites in the country. Since the design values can change after the date of publication for a variety of reasons, the information in the design value tables is intended for informational use only and does not constitute a regulatory determination by U.S. EPA as whether an area has attained a NAAQS. This document shows that the 2017-2019 annual $PM_{2.5}$ design values are below the Annual $PM_{2.5}$ NAAQS at every site in the Bay Area.

5. **Bay Area Air Quality Management District: *Preliminary Analysis of $PM_{2.5}$ Values With and Without Wildfire Smoke Episodes in 2017 and 2018*, available online at https://www.baaqmd.gov/~/media/files/technical-services/pm-2-5-design-values-re-wildfires/wildfire_pm_impacts_20201006-pdf.pdf?la=en**

   This document describes the analyses performed by the Bay Area Air Quality Management District to estimate the $PM_{2.5}$ design values without days in 2017 and 2018 impacted by wildfire smoke. This preliminary analysis provides a rough evaluation of how the $PM_{2.5}$ trends would be different without the impact of a few of the largest most recent wildfires. As shown in this document, when days impacted by wildfire are excluded, the 2017-2019 $PM_{2.5}$ design values are below the applicable standards.

6. **Xiao Wu, Danielle Braun, Marianthi-Anna Kioumourtzoglou, Francesca Dominici. "Evaluating the Impact of Long-term Exposure to Fine Particulate Matter on Mortality Among the Elderly." *Science Advances*, 2020 DOI: 10.1126/sciadv.aba5692**

   Using 16 years of data for more than 68.5 million people, this study provides strong evidence of a causal link between long-term exposure to $PM_{2.5}$ concentrations below the current NAAQS and mortality. The authors estimate that an annual standard of 10 $\mu g/m^3$ would save more than 143,000 lives in one decade compared to the current 12$\mu g/m^3$ standard.

7. **Di, Q., Wang, Y., Zanobetti, A., Wang, Y., Koutrakis, P., Choirat, C., Dominici, F. and Schwartz, J.D. (2017). "Air pollution and mortality in the Medicare population." *New England Journal of Medicine*, 376(26), 2513-2522.**

   This large-scale analysis used data from the entire U.S. population over the age of 65 — approximately 61 million people — to investigate associations between mortality and exposure to ambient $PM_{2.5}$ levels as measured by U.S. EPA data, concluding that risk of death rose significantly with $PM_{2.5}$ levels at concentrations below the 12 $\mu g/m^3$ NAAQS threshold.

8. **Environmental Protection Agency: *Memorandum on Modeling Guidance for Demonstrating Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze*, 2018, available online at https://www3.epa.gov/ttn/scram/guidance/guide/O3-PM-RH-Modeling_Guidance-2018.pdf**

   This U.S. EPA document provides modeling guidance for air quality agencies charged with satisfying federal demonstration requirements. Guidance regarding calculation of PM design values acknowledges: "it is well-established that inter-annual variability in meteorological conditions often leads to year to year differences in design values, even with static emissions levels" (p. 101).

9. **Bay Area Air Quality Management District: *West Oakland Community Action Plan: Owning Our Air*, online at https://www.baaqmd.gov/community-health/community-health-protection-program/west-oakland-community-action-plan**

This plan, shaped by a community-based steering committee, identifies specific air quality challenges in different parts of West Oakland and outlines strategies for reducing local residents' PM exposures. Chapter 5 presents a Technical Assessment that estimates the relative contributions of local and regional sources to PM concentrations, finding that proximity to local sources of PM emissions can substantially elevate exposure levels.

10. **Colmer, J., Hardman, I., Shimshack, J. and Voorheis, J., 2020. "Disparities in $PM_{2.5}$ air pollution in the United States." *Science*, 369(6503), 575-578.**

This study combined 36 years of data across approximately 65,000 census tracts to understand disparities in $PM_{2.5}$ concentration levels. The authors found that, although both overall $PM_{2.5}$ concentration levels and differences between the most and least polluted areas have decreased, disparities in $PM_{2.5}$ concentration levels persist. More-polluted areas did not experience greater relative reductions; rather, proportional decreases have been consistent across vigintiles. The most polluted areas of 1981 remained the most polluted areas of 2016.

11. **Wettstein, Zachary S, Sumi Hoshiko, Jahan Fahimi, Robert J Harrison, Wayne E Cascio, and Ana G Rappold. 2018. "Cardiovascular and Cerebrovascular Emergency Department Visits Associated with Wildfire Smoke Exposure in California in 2015." *Journal of the American Heart Association* 7 (8). Am Heart Assoc: e007492.**

This study examined patterns in hospital emergency department visits in the days following wildfire events across much of California, finding an increased likelihood of cardiovascular and cerebrovascular (stroke) events following nearby wildfires among people over the age of 65, particularly those with underlying cardiovascular conditions.

12. **Jones, C.G., Rappold, A.G., Vargo, J., Cascio, W.E., Kharrazi, M., McNally, B., and Hoshiko, S., 2020. "Out-of-Hospital Cardiac Arrests and Wildfire-Related Particulate Matter During 2015–2017 California Wildfires." *Journal of the American Heart Association*, 9(8), p.e014125.**

This study examined the frequency of cardiac arrests occurring outside a medical setting (e.g. at home, work, or in a public place) in the days following wildfire events in 14 California counties. The authors found that men and women aged 35 or older were more likely to experience sudden cardiac arrest (heart attack) on days with heavy smoke, with risks appearing further elevated for people in lower income groups.

13. California Air Resources Board: *Community Air Protection Blueprint*, online at https://ww2.arb.ca.gov/capp-blueprint

This state-level document outlines the process for meeting the requirements of California's AB 617 legislation mandating a statewide program to address long-standing air pollution concerns in disadvantaged communities. Designed to address the "unique needs of individual communities" (p. 7), the Blueprint calls for the development of community-specific action plans based on highly localized emissions, exposure, and public health data and guided by steering committees comprising local community members.

14. State of California: *AB-617 Nonvehicular air pollution: criteria air pollutants and toxic air contaminants*, online at https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB617

This state legislation mandates a statewide program to address long-standing air pollution concerns in disadvantaged communities. California air districts in which such communities are identified are tasked with designing and deploying community-level monitoring programs and exposure reduction strategies.

15. Environmental Protection Agency: *Our Nation's Air (2020)*, online at https://gispub.epa.gov/air/trendsreport/2020

This annual report from the U.S. EPA summarizes trends in air quality. In the section titled "Understanding $PM_{2.5}$ Composition Helps Reduce Fine Particle Pollution," the agency emphasizes the importance of tracking the components of secondary PM.

16. Environmental Protection Agency: *Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements; Final Rule*, online at https://www.govinfo.gov/content/pkg/FR-2016-08-24/pdf/2016-18768.pdf

a. Section B.1
b. Section G

This U.S. EPA document describes requirements to be met in implementing National Ambient Air Quality Standards for $PM_{2.5}$.

(a) The agency specifies that these rules and regulations apply to "numerous and diverse sources" of harmful emissions (Section B.1, p. 58012).
(b) Section G, "Measures to Ensure Appropriate Protections for Overburdened Populations," articulates the importance of protecting communities whose health is disproportionately impacted by $PM_{2.5}$ exposure.

17. Achilleos, S., Kioumourtzoglou, M.-A., Wu, C.-D., Schwartz, J.D., Koutrakis, P., Papatheodorou, S.I., 2017. "Acute effects of fine particulate matter constituents on mortality: A systematic review and meta-regression analysis." ***Environment International*** **109, 89–100.**

This meta-analysis combined data from all relevant studies investigating links between PM2.5 particle constituents and mortality through July 2015 (a total of 41 studies covering 142 cities in several world regions). The authors found evidence that exposure to the elemental carbon (EC) and potassium (K), generally recognized as traffic and wood combustion elements respectively, are each associated with increased risk of mortality. They also observed that health effects varied by region.

18. Yang, Y., Ruan, Z., Wang, X., Yang, Y., Mason, T.G., Lin, H., Tian, L., 2019. "Short-term and long-term exposures to fine particulate matter constituents and health: A systematic review and meta-analysis." ***Environmental Pollution*** **247, 874–882.**

This meta-analysis reviewed all relevant studies through August 2018 examining mortality and morbidity in relation to exposure to different components of PM. The authors found consistent associations between cardiovascular morbidity and mortality and exposure to black carbon and organic carbon (associated with a range of combustion including motor vehicle emissions and biomass burning). They also found likely associations between cardiovascular health effects and exposure to PM2.5 nitrate, sulfate, zinc, silicon, iron, nickel, vanadium, and potassium; and likely associations between respiratory health effects and exposure to PM2.5 nitrate, sulfate, and vanadium.

19. Ohlwein, S., Kappeler, R., Joss, M.K., Künzli, N., Hoffmann, B., 2019. "Health effects of ultrafine particles: A systematic literature review update of epidemiological evidence." ***International Journal of Public Health*** **64, 547–559.**

This meta-analysis reviewed 85 recent studies (published 2011 through 2017) of the health effects of ultrafine particles (UFP) in ambient air pollution. The authors found some evidence for increased risk of short-term inflammatory and cardiovascular effects with UFP exposure beyond the expected effects of larger categories of PM.

20. Independent Particulate Matter Review Panel: ***Final letter to Administrator Wheeler with the IPMRP's recommendations*****, October 22, 2019. Available online at https://www.ucsusa.org/meeting-independent-particulate-matter-review-panel**

This letter, written by the scientists who made up the U.S. EPA's Clean Air Scientific Advisory Committee (CASAC) before it was dismissed without notice in 2018, contains these experts' findings after reviewing the EPA's Integrated Science Assessment (ISA, Reference 2) and Policy Assessment (PA, Reference 3) regarding particulate matter. The panel strongly called for stricter PM standards based on the evidence in the ISA and PA.

Particulate Matter:
Spotlight on Health Protection

Appendix B: Summary of Advisory Council Deliberations

APPENDIX B: ADVISORY COUNCIL MEETING OF JULY 31, 2020 SUMMARY OF DELIBERATIONS

The Bay Area Air Quality Management District (Air District) Advisory Council meeting of July 31, 2020, concluded with the Advisory Council's discussion of three sets of messages regarding particulate matter. The first set, "Particulate Matter Reduction Statements," reflects the Advisory Council's findings upon review of the presentations and public comments received during the PM Symposium Series. The second set, "Framework," reflects the Advisory Council's suggested guiding principles for PM projects and rule development. The third set, "Recommended Actions," contains specific recommended priorities for Air District action. When finalized, the Statements, Framework, and Recommended Actions will be submitted to the Executive Board as Advisory Council recommendations.

Chair Stan Hayes, who composed a preliminary draft of the document, presented the Statements, Framework, and Recommended Actions to the Advisory Council members. He explained that the document was intended to reflect sentiments expressed by Advisory Council members in prior PM deliberations. By drafting these items, he hoped to provide a starting point for discussion.

The ensuing deliberations, led by Chair Hayes, focused on each individual entry under the "Statements" and "Framework" headings. (Due to time constraints, discussion of "Recommended Actions" was reserved for the next Advisory Council meeting.) Some items were immediately approved by Advisory Council members as written in the preliminary draft; others led to discussion and revision. This summary provides a high-level recap of those discussions.

PARTICULATE MATTER REDUCTION STATEMENTS DISCUSSION

After establishing the need to reorder the Particulate Matter Reduction Statements for greater clarity, the Advisory Council considered each item individually.

Particulate Matter Reduction Statements Approved

The following Particulate Matter Reduction Statements were approved without significant changes.

The current PM NAAQS are not sufficiently health protective.

PM is the health risk driver in Bay Area air, both $PM_{2.5}$ as a criteria pollutant and diesel PM as a toxic air contaminant.

There is no evidence of a health effects $PM_{2.5}$ threshold; thus, additional PM reductions beyond the current standards will achieve additional public health improvement.

More stringent standards are needed and would save thousands of lives in the U.S. each year.

*Some PM localized hot-spot areas experience PM levels significantly higher than their community-average level.**

*The qualifier “may” was removed from this statement, which previously contained the phrase “may experience.”

Particulate Matter Reduction Statements for Revision

Three Particulate Matter Reduction Statements related to attainment of potential $PM_{2.5}$ standards or targets were discussed at greater length:

Excluding wildfire smoke days as exceptional events, the Bay Area has attained the current federal annual/24-hour (12/35 μg/m^3) $PM_{2.5}$ national ambient air quality standards (NAAQS).

The Bay Area also would attain alternative, more stringent 10/25 μg/m^3 $PM_{2.5}$ NAAQS (except for West Oakland, whose annual average $PM_{2.5}$ in 2018 was above an alternative 10 μg/m^3 standard by 0.7 μg/m^3, or 7%).

An Air District guideline "target" below the current $PM_{2.5}$ NAAQS is warranted; to be effective, it would need to be at or below an annual average of 10 μg/m^3.

To explain the rationale for these Particulate Matter Reduction Statements, Chair Hayes presented graphs of Bay Area design values for each three-year period from 2005 through 2018. Design values are calculations of average concentration levels; the annual design value is the three-year average of the highest maximum $PM_{2.5}$ concentrations measured in the area, and the 24-hour design value is the three-year average of the 98th percentile of the daily maximum $PM_{2.5}$ concentration in the area. Chair Hayes used design value data provided by the Air District from each of its 16 monitoring stations to create the graphs, excluding wildfire events.

Based on the Air District’s calculations, Chair Hayes recognized that the Bay Area has in recent years attained the current federal annual 12 μg/m^3 standard at all monitoring locations (**Figure 1**). If targets were set at 10 μg/m^3, recent measurements indicate that air quality near the monitoring stations in West Oakland and Laney College would not meet the 10 μg/m^3 target. If targets were set at 8 μg/m^3, these historical data suggest that nearly all monitoring stations would register Bay Area air quality that would not meet the 8 μg/m^3 target.

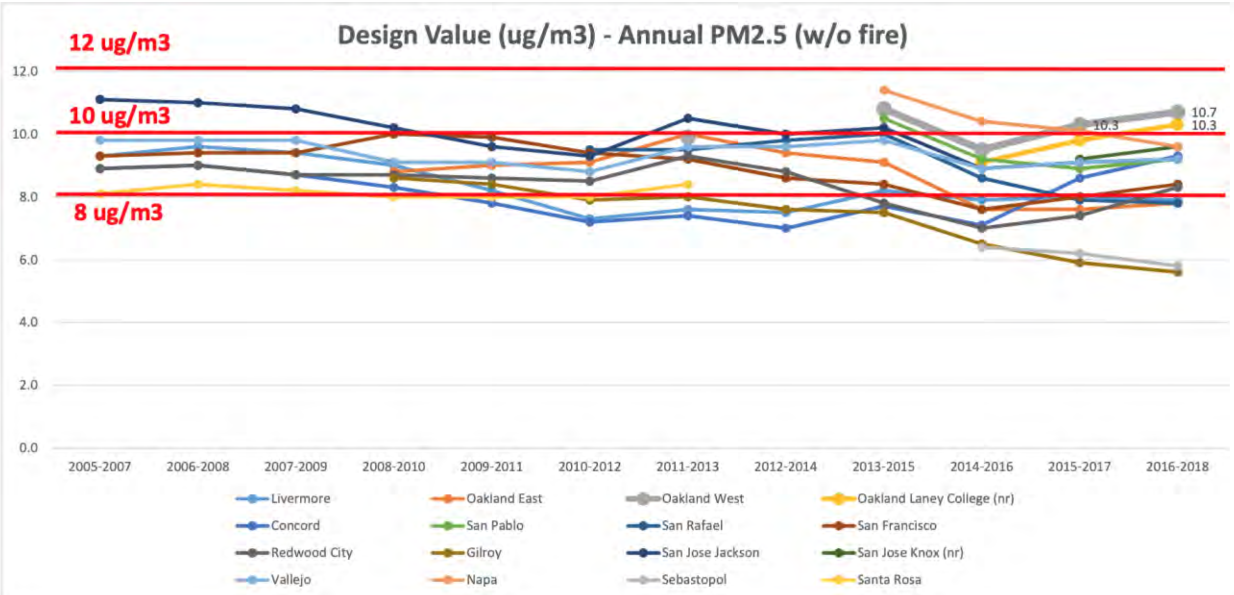

Figure 1 - Estimated annual design values for 16 Air District monitoring stations, 2005-2018

For the 24-hr design values, the Bay Area has been in attainment with the current standard of 35 µg/m^3 for the past decade (**Figure 2**). If targets were set at the more stringent standard of 25 µg/m^3, the most recent data indicate Bay Area air quality would have attained (or in West Oakland and San Jose come very close to attaining) this target.

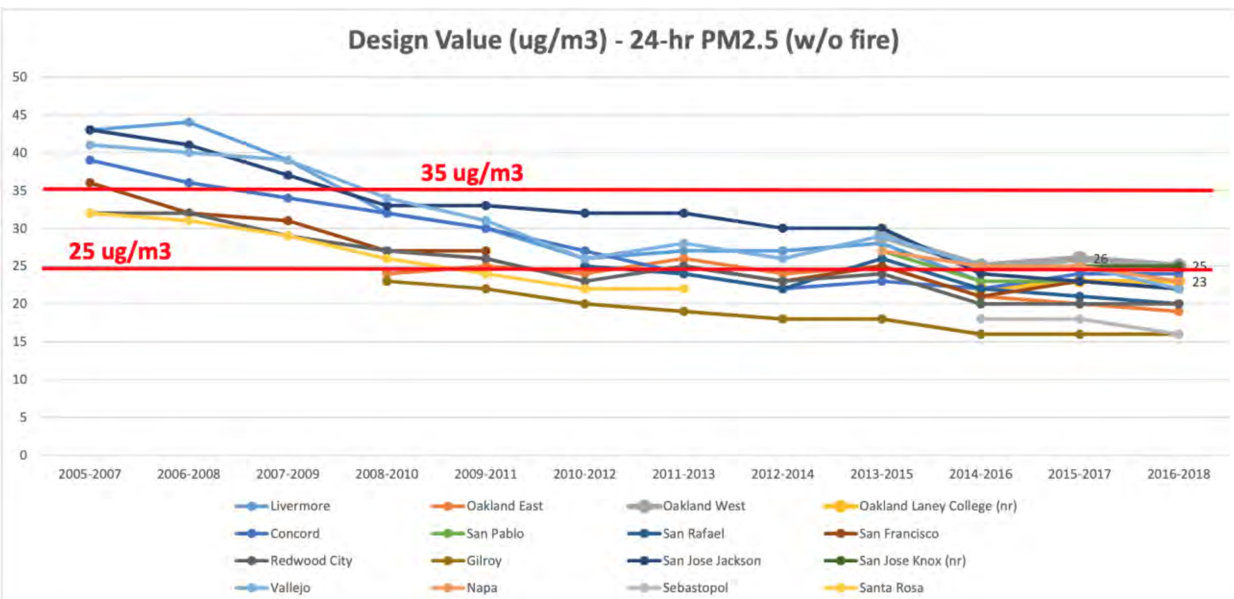

Figure 2 - Estimated 24-hr design values for 16 Air District monitoring stations, 2005-2018

Discussion centered on the following topics:

Wildfire. Advisory Council members acknowledged that if wildfire data were included, design values based on monitoring data would show $PM_{2.5}$ concentrations in excess of the current federal annual standard of 12 µg/m^3 and the current federal 24-hr standard of 35 µg/m^3.

Localized hot-spots. Although Air District data provided some indication of the differences in air quality across the region by showing separate design values for each monitoring station, Advisory Council members acknowledged that $PM_{2.5}$ concentrations may be higher in specific neighborhoods.

Achieving 8 µg/m^3 vs 10 µg/m^3. Acknowledging that the data and conclusions presented to the Advisory Council throughout the PM Symposium Series indicate meeting more stringent targets would achieve greater health protection, Advisory Council members determined that the statements should reflect the possibility of setting an annual target at 8 µg/m^3.

Bright-line standard vs linear dose-response model. Recognizing that there appears to be a linear dose-response relationship between $PM_{2.5}$ exposure and health effects, Advisory Council members discussed whether it was appropriate to set specific targets (such as annual design values of 8 µg/m^3 or 10 µg/m^3) rather than considering air quality objectives in reference to a no-threshold, linear dose-response. An alternative approach was proposed to evaluate potential projects by using health impact models (e.g., projected shifts in emergency department visits, deaths, missed work or school days) to estimate costs or benefits of a change in $PM_{2.5}$ concentration resulting from each project.

REVISIONS

The Advisory Council made the following determinations regarding revision of the three Particulate Matter Reduction Statements:

Statement:

Excluding wildfire smoke days as exceptional events, the Bay Area has attained the current federal annual/24-hour (12/35 µg/m^3) $PM_{2.5}$ national ambient air quality standards (NAAQS).

Revision: Clarify that the Particulate Matter Reduction Statement refers to the Bay Area as a whole and that localized hot-spots may exceed these standards.

Statement:

The Bay Area also would attain alternative, more stringent 10/25 µg/m^3 $PM_{2.5}$ NAAQS (except for West Oakland, whose annual average $PM_{2.5}$ in 2018 was above an alternative 10 µg/m^3 standard by 0.7 µg/m^3, or 7%).

Revision: Amend the statement to also reflect Bay Area $PM_{2.5}$ concentration levels relative to a potential annual target of 8 µg/m^3.

Statement:

An Air District guideline "target" below the current $PM_{2.5}$ NAAQS is warranted; to be effective, it would need to be at or below an annual average of 10 µg/m^3.

Revision: Reword the statement to reflect, based on the Air District's design-value data Chair Hayes presented, that keeping annual $PM_{2.5}$ concentrations at or below 10 µg/m^3 would save additional lives. Advisory Council members also discussed the possibility of amending the statement to reflect the absence of a $PM_{2.5}$ threshold for health impacts and indicate that, accordingly, the goal of the Air District should be to achieve the lowest $PM_{2.5}$ concentrations possible.

FRAMEWORK DISCUSSION

<u>Framework Items Approved</u>

The following Framework items were approved without significant changes.

The most effective PM reduction measures may differ across communities, due to varying source mix and size, ambient PM concentration levels, physical circumstances (e.g., meteorology, terrain), and other relevant factors.

The Air District should focus PM reduction in areas with increased exposure, health vulnerability, and the areas with increased impacts and sensitive populations (e.g., children, nonwhite, low socioeconomic status, elderly).

PM measures should consider regional (Bay Area-wide), local (community-level), and localized hot-spot (block-level) sources.

*PM reduction strategies will need to address multiple source categories.**

* This statement was amended to remove a second clause that was deemed unnecessary. The second clause read: "there is no 'silver bullet,' rather, it is more like 'silver buckshot.'"

Framework Items for Revision

The Advisory Council made the following determinations regarding revision of three Framework items:

Framework Item:

Where the air district has authority, take maximal action.

Revision: Reflect the urgency of the problem and the feasibility of potential solutions. Language proposed during the meeting read: "move quickly to take maximal feasible action."

Framework Item:

Lower-income populations with higher long-term PM exposure are more susceptible to COVID-19, due to such factors as lesser ability to work from home, denser housing situations (e.g., congregate, multi-family), and poorer access to medical care.

Revision: Three possibilities were proposed for later consideration:

Delete this item, as its purpose is already reflected in the Framework item calling for Air District efforts to focus on populations at greater risk.

Substitute more general language, e.g.: "The emergence of the COVID-19 pandemic makes the attention to particulate matter even more urgent."

Add more specific language to describe the multiple ways that PM exposure and COVID-19 interact to increase health risk for vulnerable populations (e.g., each can cause or exacerbate health conditions that increase susceptibility to the other; both are associated with racial disparities; PM exposure may directly lead to increased health risk from COVID-19).

Framework Item:

PM reduction strategies should consider emission reduction measures for both primary PM and secondary PM formed in the air by photochemical processes (i.e., emissions of precursor ROG, NOx, NH_3, and SO_2).

Revision: A slight change was made to acknowledge secondary PM formation processes that are not photochemical. The revised version reads: *PM reduction strategies should consider emission reduction measures for both primary PM and secondary PM formed in the air (e.g., emissions of precursor ROG, NOx, NH_3, and SO_2).*

NEXT STEPS

Due to time constraints, the Advisory Council determined that the “Recommended Actions” would be discussed at the next Advisory Council meeting, scheduled for October 9. Further revisions to the Statements and Framework are also expected to be discussed at that meeting.

APPENDIX B: ADVISORY COUNCIL MEETING OF OCT. 9, 2020 SUMMARY OF DELIBERATIONS

Continuing a discussion that began during its July 31 meeting, the October 9 meeting of the Bay Area Air Quality Management District Advisory Council centered on three sets of messages regarding particulate matter. The first set, "Particulate Matter Reduction Statements," reflects the Advisory Council's findings upon review of the presentations and public comments received during the PM Symposium Series. The second set, "Framework," reflects the Advisory Council's suggested guiding principles for PM projects and rule development. The third set, "Recommended Actions," contains specific recommended priorities for Air District action. When finalized, the Particulate Matter Reduction Statements, Framework, and Recommended Actions will be submitted to the Executive Committee of the Air District Board of Directors as Advisory Council recommendations.

During its previous meeting on July 31, the Advisory Council made suggestions for reordering and revising some of the Particulate Matter Reduction Statements and Framework items. The first focus for deliberation at the October 9 meeting was to review these changes and updates. The Advisory Council then turned to the Recommended Actions. Time constraints limited the discussion to a subset of those items.

This summary provides a high-level synthesis of these discussions, beginning by describing the broad issues raised relevant to all three types of messages, and proceeding to Advisory Council members' more focused critiques of the Particulate Matter Reduction Statements, Framework, and Recommended Actions respectively. A full and sequential record of these discussions is available on the Air District website, as noted in Appendix D.

OVERARCHING TOPICS FOR ADVISORY COUNCIL RECOMMENDATIONS

A number of broad topics were raised by the Advisory Council members and Air District Board of Directors Chair Rod Sinks relevant to the Advisory Council's recommendations as a whole: the limits of the Air District's authority with respect to setting air quality standards; the value of recommending a "bright-line" target for PM concentration levels versus a dose-response framework; the importance of addressing wildfire contributions to PM exposure; the Board's desire for guidance on approaches to decision making; and presentation considerations including source citations and organizing items as discrete, stand-alone statements versus logically structured arguments.

Standards and Air District authority

Advisory Council members requested clarification on the Air District's authority with respect to setting air quality standards and the distinction between a "standard" and a "target." Air District Counsel Brian Bunger clarified that standard-setting is done at the federal and state levels, whereas attainment of those standards is the responsibility of the Air District. However, the Air District has the authority to set targets that are stricter than these standards and to develop rules and regulations designed to achieve such targets. Furthermore, the Air District has broad latitude to regulate toxic air contaminants, which include diesel PM. If other species of PM were to be designated as toxic air contaminants, they would be covered under Air District rules including 11-18 (Reduction of risk from air toxic emissions at existing facilities) and 2-5 (New source review of toxic air contaminants).

Recommending a bright-line target vs dose-response model

Several Advisory Council members voiced support for explicitly recommending that the Air District set a $PM_{2.5}$ annual target consistent with the Advisory Council's findings. Based on the U.S. EPA's most recent Integrated Science Assessment (ISA) and Policy Assessment (PA) concerning PM, as well as review of these documents by the Independent Particulate Matter Review Panel of expert scientists, this target could be justified at a level from 10 µg/m^3 to as low as 8 µg/m^3.

Concern was raised that a "bright-line" target may not be consistent with the Advisory Council's findings (based on the evidence presented in the U.S. EPA ISA) regarding an apparently linear, no-threshold dose-response relationship between $PM_{2.5}$ exposure and health effects. As in the July 31 Advisory Council meeting, it was proposed the Advisory Council consider instead approaching $PM_{2.5}$ in the same manner as carcinogens, pursuing reduction efforts analogous to controls on toxic substances such as lead, and perhaps using metrics such as hospital emergency department visits.

Accounting for wildfire contributions to PM exposure

Although wildfires have historically been treated as "exceptional events" rather than integrated into most analyses of air quality progress, several Advisory Council members expressed that the increasing duration and intensity of wildfires in the Bay Area have made this designation inaccurate: wildfires can no longer be regarded as rare occurrences. With wildfires expected to continue worsening due to climate change, Advisory Council members argued for explicitly acknowledging this trend, incorporating wildfire exposure into $PM_{2.5}$ exposure models, and making wildfire mitigation and management efforts a priority for the Air District.

Acute risks from short-term exposure to wildfire smoke were emphasized in addition to the contribution of wildfire days to annual concentration averages. For example, if the Air District were to set and meet the equivalent of an annual target of 8 µg/m^3 for the region, wildfires resulting in 30 days of exposure to 150 µg/m^3 would bring the annual average up to 20 µg/m^3, well beyond even the federal standard of 12 µg/m^3. Board Chair Sinks shared that the Air District has obtained a small amount of funding from the State of California to establish "clean air centers" in which vulnerable populations in communities heavily impacted by wildfires can shelter during wildfire outbreaks.

Providing the Board of Directors with guidance for decision making

Board Chair Sinks expressed his hope that the Advisory Council's recommendations would provide guidance on how to evaluate different options for pursuing PM exposure reductions. He shared the example of the October 1 Stationary Source Committee meeting, in which two different types of emissions controls were considered for Fluidized Catalytic Cracking Units (which convert crude oil into petroleum products such as gasoline). He stated that the Board would benefit from the Advisory Council's advice on how to compare the more stringent control model with its more cost-effective alternative in light of numerous potential impacts including health and economic considerations. To support this and other PM reduction decisions, he encouraged the Advisory Council to provide the Board with tools for evaluating such trade-offs.

Presentation of the Advisory Council's recommendations

The ordering of items in the Particulate Matter Reduction Statements, Framework, and Recommended Actions was a topic of discussion. The question arose of whether to treat each entry as a discrete, stand-alone item or to instead ensure they are written and organized in such a way that they build on one another in the manner of a logical argument. An additional suggestion was to link Particulate Matter Reduction Statements to corresponding Framework items and Recommended Actions.

Another presentation concern was ensuring key scientific sources (such as the U.S. EPA ISA) are referenced in findings that rely on the evidence provided by those sources. Chair Stan Hayes shared that the Air District team is preparing an annotated bibliography for the Statements and Framework intended to supply these references.

PARTICULATE MATTER REDUCTION STATEMENTS DISCUSSION

Particulate Matter Reduction Statements Approved:

Advisory Council members agreed on the wording of two of the Particulate Matter Reduction Statements as they were presented during the meeting:

PMRS1*) PM is the health risk driver in Bay Area air, both $PM_{2.5}$ as a criteria pollutant and diesel PM as a toxic air contaminant.*

PMRS9*) Although a large fraction of $PM_{2.5}$ is regionally contributed, substantially elevated $PM_{2.5}$ exposures can occur in locations adjacent to local PM sources.*

Particulate Matter Reduction Statements for Revision:

Advisory Council members raised concerns and made suggestions for revising eight Particulate Matter Reduction Statements. These discussion points are summarized beneath each Particulate Matter Reduction Statement.

PMRS2*) The current PM national ambient air quality standards (NAAQS) are not sufficiently health protective.*

- Concern was raised over the use of the term "sufficient" in this statement, as it was viewed as necessitating precise delineation of an acceptable level of health protection. A proposal was made to instead express the need for "improvements" in PM targets and health protection.

PMRS3*) More stringent standards are needed and would save thousands of lives in the U.S. and many Bay Area lives each year.*

- An insertion was made to clarify that more stringent standards, "*if met*," would save lives.

- Concern was raised over the lack of quantification regarding mortality or morbidity.

- It was noted that this Particulate Matter Reduction Statement and PMRS6 may duplicate one another.

PMRS4*) There is no evidence of a health effects $PM_{2.5}$ threshold; thus, it follows that additional PM reductions beyond the current standards will achieve additional public health benefits.*

- Discussion of this statement centered on the nature of the concentration-response relationship and whether the absence of a health effects threshold necessarily justifies a more stringent target. A potential counterargument was presented that effects could theoretically *approach* zero below a certain threshold without ever reaching zero (i.e. there could be an asymptote). Advisory Council members clarified that the U.S. EPA ISA demonstrates that evidence points to a linear or near-linear concentration-response relationship between PM exposure and health effects.

- The Particulate Matter Reduction Statement was marked for revision. A preliminary revision was drafted to read: *"There is no known safe level of exposure to $PM_{2.5}$, thus it follows that additional PM reductions beyond the current standards will achieve additional public health benefits."*

***PMRS5**) With the exception of data affected by wildfire emissions, PM concentrations in the Bay Area region would be at or below existing applicable state and federal ambient air quality standards.*

- As discussed in Section 1 above, the Advisory Council agreed that the current and projected frequency, duration, and intensity of California wildfires require approaching them as non-exceptional events.

- A proposal was made to consider setting air quality targets at a level that, when averaged with days affected by wildfire, would result in a health protective annual average.

- The appropriateness of stating the Bay Area region meets existing standards was questioned due to the Advisory Council having found those standards inadequate and to the concern that some hot-spot areas experiencing higher $PM_{2.5}$ concentration levels have not historically been captured by the Air District's monitoring network.

- The Particulate Matter Reduction Statement was marked for revision. A preliminary revision was drafted to read: *"The Bay Area has made substantial progress at reducing regional $PM_{2.5}$ levels to meet current $PM_{2.5}$ standards, however, 1) exposures vary substantially across communities; 2) wildfire smoke increases exposures substantially above standards; and 3) more stringent standards would be more health protective."*

***PMRS6**) With additional PM emission reductions, the Bay Area region could also make progress toward more stringent alternate standards providing an additional public health benefit to communities.*

- The word "alternate" was removed from the Particulate Matter Reduction Statement.

- The Particulate Matter Reduction Statement was marked for revision.

***PMRS7**) Allowance should be made for year-to-year variability in meteorological and other weather-related factors that cause PM concentrations to vary, even if emissions and other conditions were to remain unchanged.*

- Advisory Council members expressed confusion regarding the purpose of this Particulate Matter Reduction Statement and the term "allowance."

- The Particulate Matter Reduction Statement was marked for revision.

***PMRS8**) An Air District guideline "target" below the current $PM_{2.5}$ NAAQS may be warranted; if the Air District were to set that target at an annual average of 10 µg/m^3 to as low as 8 µg/m^3, national data supports that it would save additional lives.*

- Advisory Council members expressed concern that setting targets for the region fails to address problems of equity and heterogeneity: some people in the Bay Area are more vulnerable to harm from $PM_{2.5}$ and some areas experience higher $PM_{2.5}$ concentrations.

- Advisory Council members also requested that the source for the specific concentration targets (the U.S. EPA ISA) be referenced.

- The Particulate Matter Reduction Statement was marked for revision.

- Later in the meeting, during the discussion of Recommended Actions, Advisory Council members returned to the topic of impact metrics such as specifying how many lives would be saved if a more stringent target was met. (The research the U.S. EPA used to quantify morbidity did not include the Bay Area.)

PMRS10*) Wildfire PM is a serious contributor to PM health effects; early health studies are of concern; more research on acute and sub-chronic effects is ongoing and urgently needed.*

- Advisory Council members emphasized the need to treat wildfire PM exposure as an urgent problem that the Air District must address.

- Advisory Council members expressed the importance of both "acute" risks from wildfire smoke exposure as well as "chronic" risks of ongoing exposure to $PM_{2.5}$ from other sources.

- The following addition was made to the Particulate Matter Reduction Statement: *"Wildfire PM exposure is projected to increase in duration and intensity, due to climate change."*

FRAMEWORK DISCUSSION

There was general agreement among Advisory Council members on most of the Framework items. The following suggestions were made:

- Specify scientific evidence for designation of vulnerable groups. A preliminary revision was made to *F3* to clarify which subpopulations the U.S. EPA ISA identifies as disproportionately vulnerable to $PM_{2.5}$ health risks.

- Reorder to move to the top the following items related to health equity and exposure heterogeneity:

***F3)** The Air District should focus PM reduction in areas with increased exposure, health vulnerability, and those areas with increased impacts and sensitive populations (e.g., U.S. EPA identifies children, nonwhite, low socioeconomic status, elderly).*

***F7**) PM reduction strategies should prioritize those measures that are most effective in reducing exposure and improving public health and health equity in the most impacted areas.*

***F2**) The most effective exposure reduction measures may differ across communities, due to varying source mix and size, ambient PM concentration levels, physical circumstances (e.g., meteorology, terrain), and other relevant factors.*

RECOMMENDED ACTIONS DISCUSSION

The discussion of Recommended Actions included general considerations of prioritization and scope in addition to the suggestion of a new Recommended Action to set a $PM_{2.5}$ target.

Air District authority vs advocacy. A general discussion topic concerning Recommended Actions was whether to prioritize actions under the control of the Air District rather than advocacy activities intended to influence state and federal governing bodies. The Advisory Council discussed the possibility of organizing recommendations into separate categories for a) direct actions available to the Air District and b) advocacy actions directed toward other authorities.

Staffing is outside Advisory Council's scope. A number of the draft Recommended Actions concerned increases in staff. The Advisory Council determined that it was beyond its scope to make recommendations regarding the Air District's management and allocation of human resources.

Setting a specific $PM_{2.5}$ target. Several Advisory Council members called for adding a Recommended Action that the Air District set a $PM_{2.5}$ annual target consistent with the Particulate Matter Reduction Statements.

<u>Discussion of individual Recommended Actions</u>

***RA1**) Make air quality data more accessible and closer to real time.*

- Air District staff clarified that while a goal is to make data available as quickly as possible (currently posted every 20 minutes), quality control, quality assurance, and sample analysis measures make "real time" accessibility unfeasible.

- The Recommended Action was revised to read: *"Continue working to make air quality data more accessible and timely."*

***RA2**) Some species of PM may be more dangerous than others; as yet, no PM species can be exonerated; better PM speciation is needed, along with more monitoring.*

- Air District staff clarified that, although the Air District will continue to expand its PM speciation measurement efforts, in order to drive policy, it is necessary to conduct health research at a national scale, which is beyond the Air District's capacity.

- The Recommended Action was revised to read: *"Some species of PM may be more dangerous than others; as yet, no PM species can be exonerated. Make current PM speciation data more available. Advocate for the U.S. EPA national monitoring guidance and requirements to increase PM speciation."*

***RA3**) Monitoring and other studies for UFP are important and should be continued and expanded; further studies linking UFP and health impacts are needed.*

- Air District staff clarified that the Air District will continue its UFP measurements and evaluate whether changes of the measurement network are warranted. However, in order to drive policy, it is necessary to conduct health research at a national scale, which is beyond the capacity of the Air District.

- The Recommended Action was revised to read: *"Advocate for increased, broader, national monitoring and studies of UFP; support further national studies on the health impacts of UFP."*

***RA4**) Set improved UFP filtration requirements for on-road vehicles.*

- Regulation of mobile sources is outside the Air District's authority.

- The Recommended Action was revised to read: *"Advocate for appropriate federal and state agencies to set improved UFP filtration requirements for on-road vehicles."*

***RA5**) Increase staff for enforcement and accidental release events.*
***RA6**) Increase staff to implement/enforce Rule 11-18.*
***RA7**) Devote more staff to risk assessment for air toxics programs like Rule 11-18.*

- Advisory Council members expressed that it is beyond the Advisory Council's scope to make specific recommendations regarding the Air District's management of human resources.

- The three Recommended Actions were revised into one: *"Strengthen implementation and enforcement of programs and rules intended to reduce exposures to $PM_{2.5}$ (including diesel PM) and seek sufficient resources to do so."*

***RA8**) Improve emission estimation methods for emerging source categories (e.g., tires and brakes, road dust).*

- Air District staff clarified that the California Air Resources Board (CARB) is currently working on improving estimation methods for brake and tire wear and road dust; while the Air District has the authority to conduct its own research, partnering with CARB would avoid duplicating these efforts and would be a more efficient use of resources. Additionally, the Air District has established that reduction of vehicle miles traveled (VMT) is a priority regarding on-road mobile-source emissions.

- The Recommended Action was revised to read: *"Advocate for improved emission estimation and control methods for emerging source categories (e.g., tires and brakes, road dust)."*

***RA9**) Develop Air District PM action plans for individual highly impacted communities.*

- Advisory Council members suggested adding the term "strategic" to "action plans" and linking these plans to specific PM reduction targets.

- The Recommended Action was revised to read: *"Develop Air District PM strategic action plans for individual highly impacted communities with appropriate targets."*

***RA10**) Further develop and implement health protective measures for the community during wildfires.*

- Advisory Council members suggested adding the terms "strategy" and "guidance."

- The Recommended Action was revised to read: *"Further develop and implement a strategy of health protective measures and guidance for the community during wildfire episodes."*

***RA11**) Encourage telework.*

- Advisory Council members expressed that the goal of encouraging telework is to reduce VMT, and telework is not available to everyone; the Advisory Council's recommendations should therefore support a range of strategies, including telework, that reduce VMT.

- The Recommended Action was revised to read: *"Implement and encourage strategies to reduce vehicle miles traveled (e.g., active transportation, public transit, telework where possible, and land use planning)."*

***RA12**) Conduct community-level health exposure assessments.*

- Advisory Council members raised the possibility of specifically referencing California's AB 617, which mandates a statewide program to address long-standing air pollution concerns in disadvantaged communities. Air District staff expressed their intention that ongoing localized health impact assessment efforts, in addition to satisfying AB 617, also go beyond these state-level requirements.

- The Recommended Action was revised to read: *"Expand community-level exposure and health impact assessments."*

***RA13**) Expand existing rule limiting visible emissions and trackout (Rules 6-1, 6-6) to address communities that are overburdened or experience continuous construction.*

- Air District staff expressed a preference for broader language not limiting recommendations to specific rules.

- The Recommended Action was revised to read: *"Evaluate improvements to existing rules limiting visible emissions and trackout of road dust to address communities that are overburdened."*

***RA14**) Modify permitting regulations to address hyper-localized health risks.*

- The Recommended Action was revised to insert the word "hot-spot" before "health risks."

***RA15**) Adopt rule requiring that woodburning devices be disabled or replaced when properties are sold.*

- Advisory Council members discussed the possibility of expanding the recommendation to include home renovations as well as sales.

- Concerns were raised regarding burdens on homeowners, the possibility of such a rule leading to more people making changes to their homes without seeking permits, and the potential for gas fireplaces to be used as replacements, which would introduce other air quality problems.

- The Recommended Action was marked for revision.

***RA16**) Adopt rule to improve the efficiency of water heaters and space heaters.*

- Air District staff clarified that the relevant concern is emission of nitrogen oxides (NOx), which leads to the formation of ammonium nitrate (a form of particulate matter).

- Advisory Council members discussed clarifying the goal of electrification.
- The Recommended Action was marked for revision.

NEXT STEPS

Due to time constraints, the Advisory Council determined that it would discuss the remaining Recommended Actions at the next Advisory Council meeting, scheduled for November 9. Advisory Council members were asked to submit any further comments on the Particulate Matter Reduction Statements, Framework items, and Recommended Actions to Air District staff by October 16. The plan was established for Air District staff to compile these comments, without attribution, and include them in the publicly available materials for the November 9 meeting.

APPENDIX B: ADVISORY COUNCIL MEETING OF NOV. 9, 2020 SUMMARY OF DELIBERATIONS

Continuing discussions from its July 31 and October 9 meetings, the Advisory Council centered its November 9, 2020 meeting on three sets of messages regarding particulate matter. The first set, "Particulate Matter Reduction Statements," reflects the Advisory Council's findings upon review of the presentations and public comments received during the PM Symposium Series. The second set, "Framework," reflects the Advisory Council's suggested guiding principles for PM projects and rule development. The third set, "Recommended Actions," contains specific recommended priorities for Air District action. When finalized, the Particulate Matter Reduction Statements, Framework, and Recommended Actions will be submitted to the Board of Directors.

After discussing each item in each set of messages, the Advisory Council identified a need to reorganize the Recommended Actions into topical categories reflecting key messages of the Particulate Matter Reduction Statements and Framework. A revised draft of the Recommended Actions will be prepared by a subcommittee of the Advisory Council and discussed at an additional Advisory Council meeting to take place before the Advisory Council's December 16 meeting with the Board of Directors.

This summary recaps the Advisory Council's discussion of the Particulate Matter Reduction Statements, Framework, and Recommended Actions, indicating which items were approved without substantive revision and providing brief descriptions of discussion points for those that were substantively revised. An introductory section briefly summarizes topics of discussion that arose during deliberations and have relevance to all three sets of messages, and a final section reflects input from public comment.

For a full and sequential record of the November 9 meeting, please see the video recording available at http://baha.granicus.com/MediaPlayer.php?clip_id=7783.

OVERARCHING TOPICS FOR ADVISORY COUNCIL RECOMMENDATIONS

A number of broad topics arose during deliberations: the inclusion of 10 $\mu g/m^3$ as a potentially viable target for annual average $PM_{2.5}$ concentration levels, the public health cost effectiveness of focusing on "controllable" sources of PM emissions versus mitigation measures for wildfire PM exposures, the relevance of climate impacts in determining PM reduction measures, and the practical value of obtaining authority for the Air District to set air quality "standards" rather than "target values."

Including 10 μg/m^3 as a viable target

Some Advisory Council members, and public commenters, objected to including 10 μg/m^3 as a potentially viable target for annual average $PM_{2.5}$ concentration levels, arguing that the scientific findings presented during the PM Symposium Series justified a target of 8 μg/m^3. Other Advisory Council members were in favor of keeping an upper limit of 10 μg/m^3 in the recommendations, regarding the language of "10 μg/m^3 to as low as 8 μg/m^3" as most consistent with the findings of the U.S. EPA PM Policy Assessment and the Independent Particulate Matter Review Panel.

Relative influence of "controllable" sources

Concern was voiced about the public health cost-effectiveness of focusing on local anthropogenic sources whose PM contributions are "swamped" by that of wildfires. Questions were raised as to whether the cost of reducing "controllable" Bay Area emissions could be justified if these air quality improvements would be dwarfed by "uncontrollable" factors, and whether instead allocating those resources to indoor air purification and other wildfire responses would have a greater positive impact on public health.

Climate co-benefits

An argument raised in favor of investing in controlling emissions from local and regional sources was that doing so would also reduce greenhouse gases, which contribute to the dire public health problem of climate change. A counterargument was made that the Advisory Council is currently tasked with identifying means of reducing health impacts from particulate matter, not greenhouse gases, and that the complicated interplay between air pollution levels and climate change can mean that measures to improve one set of conditions effectively worsen the other.

Acquiring Air District authority to establish a standard

The prospect of seeking legislative authority for the Air District to set official air quality standards (which are currently set by state and federal authorities) was discussed at several points during the meeting. Some Advisory Council members, as well as representatives from community organizations speaking during public comment, expressed support for this strategy. Air District Legal Counsel stated that such a change would not add to the Air District's capacity to monitor and improve air quality and that specifying a "target" for PM concentration levels would fully enable the Air District to exercise its authority to meet that target.

PARTICULATE MATTER REDUCTION STATEMENTS DISCUSSION

Particulate Matter Reduction Statements Approved:

Advisory Council members agreed on the following Particulate Matter Reduction Statements. Minor revisions for clarity were made to some items, as indicated.

PMRS1*) Particulate Matter (PM) is an important health risk driver in Bay Area air, both $PM_{2.5}$ as a criteria pollutant and diesel PM as a toxic air contaminant.*

PMRS2*) The Bay Area has made substantial progress at reducing regional $PM_{2.5}$ levels to meet current $PM_{2.5}$ standards; however, 1) more stringent standards would be more health protective; 2) exposures vary substantially across communities; and 3) wildfire smoke increases $PM_{2.5}$ levels substantially above standards.*

- The phrase "increases $PM_{2.5}$ levels" replaced earlier wording of "increases exposure."

PMRS3) *The current particulate matter national ambient air quality standards (NAAQS) are not health protective.*

The Advisory Council concurs with the following statement: "Based on scientific evidence, as detailed in Attachment B [of our letter], the [Independent Particulate Matter Review Panel] finds that the current suite of primary fine particle ($PM_{2.5}$) annual and 24-hour standards are not protective of public health. Both of these standards should be revised to new levels, while retaining their current indicators, averaging times, and forms. The annual standard should be revised to a range of 10 µg/m^3 to 8 µg/m^3. The 24-hour standard should be revised to a range of 30 µg/m^3 to 25 µg/m^3. These scientific findings are based on consistent epidemiological evidence from multiple multi-city studies, augmented with evidence from single-city studies, at policy-relevant ambient concentrations in areas with design values at and below the levels of the current standards, and are supported by research from experimental models in animals and humans and by accountability studies." (Independent Particulate Review Panel letter on Draft EPA PM Policy Assessment, October 2019).

PMRS4*) More stringent standards to reduce exposures are needed and, if met, would save thousands of lives in the U.S. and many Bay Area lives each year.*

- The phrase "to reduce exposures" was added to the statement.

PMRS5) *There is no known threshold for harmful $PM_{2.5}$ health effects, thus is follows that additional reductions of $PM_{2.5}$ exposures beyond that afforded by the current standards will achieve additional public health benefits.*

- In the first clause, the phrase “no known threshold for harmful $PM_{2.5}$ effects” replaced the earlier phrase “no known safe level of exposure to PM.” In the second clause, the phrase “reductions of $PM_{2.5}$ exposures” replaced “reductions to PM,” and the phrase “that afforded by” was added to the statement.

PMRS8*) Although a large fraction of* $PM_{2.5}$ *is regionally contributed, substantially elevated* $PM_{2.5}$ *exposures can occur in locations adjacent to local PM sources.*

PMRS9*) Wildfire PM is a serious contributor to PM health effects; early health studies are of concern; more research on acute and sub-chronic effects is ongoing and urgently needed. Wildfire PM exposure is projected to increase in duration and intensity, due to climate change.*

PMRS10*) Some species of PM may be more dangerous than others; as yet, no PM species can be exonerated.*

PMRS11*) Ultrafine particles (UFP), which are present in the air in large numbers, pose a health risk. They generally enter the body through the upper and lower respiratory tract and can translocate to essentially all organs. Compared to fine particles (*$PM_{2.5}$*), they cause more pulmonary inflammation per unit mass, and are retained longer in the lung.*

- The phrase “upper and lower respiratory tract” replaced “lungs”; the phrase “and can translocate” replaced “but translocate.” The phrase “per unit mass” was added.

Particulate Matter Reduction Statements for Revision:

Advisory Council members discussed substantive changes to two Particulate Matter Reduction Statements. Discussion points are summarized beneath the initial version of each substantively revised Particulate Matter Reduction Statement, followed by the revised version.

Initial PMRS6) *An Air District guideline “target” below the current* $PM_{2.5}$ *NAAQS may be warranted; if the Air District were to set that target at an annual average of 10 µg/m*^{3} *to as low as 8 µg/m*^{3}*, U.S. EPA’s* $PM_{2.5}$ *NAAQS risk assessment provides scientific evidence that annual average targets in that range would save additional lives.*

Discussion: Concern was raised that the phrase “may be warranted” was not strong enough to reflect the weight of the evidence.

Revised PMRS6) *An Air District guideline “target” below the current* $PM_{2.5}$ *NAAQS is warranted to protect public health; if the Air District were to set that target at an annual average of 10 µg/m3 to as low as 8 µg/m3, U.S. EPA’s* $PM_{2.5}$ *NAAQS risk assessment provides scientific evidence that annual average targets in that range would save additional lives.*

***Initial PMRS7**) Year-to-year variability in meteorological and other weather-related factors cause PM concentrations to vary, even if emissions and other conditions were to remain unchanged.*

Discussion: Confusion was expressed regarding the intent of this statement. Once it became clear that the objective was to ensure the robustness of air quality in the face of changing conditions, the statement was revised to reflect support for strong action.

***Revised PMRS7**) Projected increases in wildfire PM exposure, as well as year-to-year variability in PM exposure due to weather-related factors, justifies greater efforts to reduce controllable sources of PM to reduce overall health risk.*

FRAMEWORK DISCUSSION

Advisory Council members agreed on all Framework items, with clarifying revisions to two items as indicated:

***F1**) The Air District should move as quickly as possible to take maximal feasible action within its authority.*

***F2**) PM reduction strategies should prioritize those measures that are most effective in reducing exposure and improving public health and health equity in the most-impacted areas.*

***F3**) The most effective exposure reduction measures may differ across communities, due to varying source mix and size, ambient PM concentration levels, physical circumstances (e.g., meteorology, terrain), and other relevant factors.*

***F4**) The Air District should focus PM reduction in areas with elevated exposures, health vulnerability, and those areas with increased impacts and sensitive populations (e.g., U.S. EPA identifies children, non-white, low socioeconomic status, elderly).*

- The phrase "elevated exposures" replaced "increased exposures."

***F5**) PM reduction strategies should consider regional (Bay Area-wide), local (community-level), and localized hot-spot (block-level) sources.*

***F6**) PM reduction strategies should consider emission reduction measures for both primary PM and secondary PM formed in the air (e.g., emissions of precursor ROG, NOx, NH_3, and SO_2).*

***F7**) PM reduction strategies will need to address multiple source categories with a wide range of emission reduction measures; there are no single, universal solutions*.

- The text that follows after "multiple source categories" is a new addition.

RECOMMENDED ACTIONS DISCUSSION

Reorganization and Prioritization:

Following the item-by-item discussion described below, Advisory Council members determined that the Recommended Actions should be reorganized into topical groups derived from key concepts expressed in the Particulate Matter Reduction Statements and Framework. Several topical headings were proposed including establishing stricter PM targets, addressing disparate PM exposures and vulnerable communities, addressing wildfire risks and mitigation, and reducing vehicle miles traveled. Advisory Council members agreed that the Recommended Actions should be categorized under such headings, and that any Recommended Actions falling outside of the selected categories might then be considered as lower priorities.

Recommended Actions Approved:

Advisory Council members agreed on the following Recommended Actions. Minor revisions for clarity were made to some items, as indicated:

***RA1**) Establish a $PM_{2.5}$ target consistent with findings based on scientific evidence (i.e., from an annual average of 10 µg/m^3 to as low as 8 µg/m^3.*

- The phrase "based on scientific evidence" was added and "i.e." replaced "e.g."

***RA2**) Continue working to make air quality data for PM and PM precursors more accessible and timely. Partner with effective platforms (e.g., PurpleAir).*

- The phrase "for PM and PM precursors" was added; "platforms" replaced "formats"; "e.g." was added before "PurpleAir."

***RA3)** Make current PM speciation data more available. Advocate for U.S. EPA national monitoring guidance and requirements to increase PM speciation.*

- The word "the" was deleted from where it appeared before "U.S. EPA."

***RA4)** Advocate for increased, broader, national monitoring, exposure, and health impact studies of UFP.*

***RA5**) Advocate for appropriate federal and state agencies to set improved UFP filtration requirements for on-road vehicles.*

***RA7**) Advocate for improved emission estimation and control methods for emerging source categories (e.g., tires and brakes, road dust).*

***RA8**) Develop Air District PM action plans for individual highly impacted communities with appropriate targets.*

***RA9**) Further develop and implement strategies including health protective measures and guidance to protect health during wildfire episodes. Such measures and guidance could include: 1) public education; 2) improved real-time monitoring and forecasting models; 3) more comprehensive research to assess short- and long-term health impacts; 4) assessment of the feasibility of strategies to reduce PM exposure in proposed forest management strategies; 5) establishment of clean air shelters (e.g., in schools, community centers, libraries, senior centers, senior living facilities) with power, HVAC/HEPA filters, personal protective equipment (PPE), etc., especially in disadvantaged communities; 6) mobile clean air shelters; and 7) strategies to provide HEPA filters for in-home high risk individuals.*

***RA10**) Develop, fund, implement, and encourage strategies to reduce vehicle miles traveled (e.g., active transportation, public transit, land use planning, and telework).*

***RA11**) Expand community-level exposure and health impact assessments.*

***RA12**) Evaluate improvements to existing rules limiting visible emissions and trackout of road dust to address communities that are overburdened.*

***RA22**) Assist local programs to control road dust (e.g., analyze road dust emission rates for local streets).*

***RA26**) Seek changes at state level to Air District authority for magnet sources.*

***RA29**) Support CARB efforts to electrify trucks and other vehicles.*

***RA30**) Seek stricter off-road mobile source rules from CARB.*

Recommended Actions for Revision:

Advisory Council members discussed substantive changes to many of the Recommended Actions. Discussion points are summarized beneath the initial version of each substantively revised Recommended Action, followed by the revised version.

Initial RA6) *Strengthen implementation and enforcement of programs and rule intended to reduce exposures to $PM_{2.5}$ (including diesel PM) and seek sufficient resources to do so.*

Discussion:

- Advisory Council members removed qualifying language, striking the word "intended" and replacing "seek sufficient resources" with "ensure necessary resources."
- Specific reference to Rule 11-18 was added.

Revised RA6) *Strengthen implementation and enforcement of programs and rules (including Rule 11-18) to reduce exposures to $PM_{2.5}$ (including diesel PM) and ensure necessary resources to do so.*

Initial RA13*) Modify permitting regulations to address hyper-localized hot-spot health risks.*

Discussion*:* Advisory Council members requested clarification on whether the Recommended Action was intended to address cumulative health risks, expressing support for modifying permitting regulations to take into account pre-existing health risks for communities near the permitting site in determining the potential health impact of permitted sources.

Revised RA13*) Modify permitting regulations to address hyper-localized hot-spot and cumulative PM health risks.*

Initial RA14) *Adopt rules incentivizing/requiring building electrification OR 'Adopt a rule requiring electric appliances rather than gas in new construction.'*

Initial RA15) *Adopt rule to improve the efficiency of water heaters and space heaters and require electrification of new heaters and other appliances.*

Discussion:

- Concern was raised regarding adding stress to the electrical grid, particularly with respect to solar and wind energy production that is lowest in winter when demand is highest due to heating needs. A counterargument was made that while resiliency problems do need to be solved, building stock turns over slowly and requiring all electric in new construction is not anticipated to create an undue burden on energy infrastructure.
- Advisory Council members sought clarification on the scope of the Air District's authority with respect to regulating appliances and systems within homes and other buildings. Air District staff clarified that while the Air District does not regulate indoor air

quality or appliance/system efficiency, it does have the authority to regulate systems that discharge emissions (through exhaust points) into ambient air.

- Air District staff pointed out that the cost of retrofitting all existing buildings in the Bay Area to switch from gas to electric heating would be in the billions and possibly tens of billions of dollars (and therefore orders of magnitude beyond the incentivizing capacity of the Air District).

- Examples of existing and emerging electrification incentive and information programs were shared, including those offered through the Air District as well as state and federal agencies and energy providers.

Revised RA14) *Adopt a rule requiring, and create a program incentivizing, all electric utilities in new construction. Continue to look for opportunities that could include training, incentives, and programs to move our existing built environment to all electric.*

Revised RA15*) Adopt rules to improve the emissions performance of water heaters and space heaters and require electrification of new heaters and other appliances.*

Initial RA16) *Expand the existing rule to reduce emissions from commercial cooking equipment such as charbroilers (Rule 6-2).*

Discussion*:* Advisory Council members argued for a broader recommendation that would include wood-fired ovens and not be limited to one specific rule.

Revised RA16*) Expand efforts to reduce emissions from commercial cooking equipment such as charbroilers and wood-fired ovens.*

Initial RA17*) Update permitting regulations for gas stations and dry cleaners (Regulation 2).*

Discussion*:* Advisory Council members questioned the intent and relevance of this recommendation with respect to PM. Air District staff expressed that both types of businesses are already tightly regulated and most dry cleaners have already switched to using non-toxic compounds.

RA17 was deleted.

Initial RA18*) Adopt amendments to Rule 9-1 to limit sulfur dioxide emissions from refineries.*

Discussion*:* The discussion centered on the spatial and temporal scale of sulfate formation and whether sulfur dioxide emissions have passed out of the Bay Area by the time they influence formation of PM. Because effects on Bay Area air quality are not yet clear, the Recommended Action was reframed as a testing recommendation.

Revised RA18*) Evaluate the efficacy of reducing sulfur in refinery fuel gas as a PM reduction strategy.*

Initial RA19*) Adopt a new rule to limit site-wide health risk from PM.*

Discussion*:* After Advisory Council members expressed confusion about this Recommended Action, Air District staff clarified that while there is presently a rule for toxics that limits the overall impact of a facility, there is no such rule governing PM. Such a rule could require an emissions reduction plan if a facility were to exceed a certain threshold of health risk (using quantifying metrics such as cancer cases per million).

Revised RA19*) Adopt a new rule to limit site-wide impacts from PM emissions.*

Initial RA20*) Take into account cumulative impact in permitting.*

Discussion*:*

- Advisory Council members questioned whether this topic was already covered (see RA13).

- Air District staff clarified the Recommended Action's intent to protect overburdened communities by incorporating considerations of existing hyper-localized PM concentration levels as well as other health vulnerabilities in the community into permitting decisions.

Revised RA20*) Develop strategies to consider cumulative community PM impacts in permitting processes.*

Initial RA21*) Close loopholes that allow piecemealing of larger projects into small components.*

Discussion*:* Discussion centered on whether such loopholes exist in current regulation and whether the "cumulative impacts" guidance captured in RA20 already addressed the issue of total impacts in a specific area, and whether this Recommended Action had a specific function with respect to PM emissions. Air District staff indicated there is legislation to prevent piecemealing as a strategy of regulatory avoidance.

RA21 was deleted*.*

RA23*) Seek federal funding for electrification infrastructure.*

Discussion*:* A suggestion was made to emphasize the need to support electrification in disadvantaged communities.

Revised RA23*) Seek federal funding for electrification infrastructure, especially for disadvantaged communities.*

Initial RA24*) Work to leverage Senate Bill 1 funding to replace switcher engines in East Bay to reduce other off-road sources.*

Discussion*:* Air District staff clarified that railroads are regulated by the federal government, which has not appeared to be receptive to the Air District's advocacy efforts in this regard.

RA24 was deleted*.*

Initial RA25*) Seek additional funding to improve transit, bicycles, and pedestrian facilities, and to reduce VMT to reduce road dust, brake & tire wear, and vehicle exhaust.*

Discussion*:* Advisory Council members emphasized the need to center the Recommended Action on reducing vehicle miles traveled (VMT), clarify the types of initiatives suggested (including specifying public transit), and tie the Recommended Action explicitly to PM reductions.

Revised RA25*) Seek additional funding to reduce vehicle miles traveled (VMT) (e.g., improved public transit, bicycle and pedestrian infrastructure, facilities, and programs) in order to reduce PM from road dust, brake & tire wear, and vehicle exhaust.*

Initial RA27*) Authorize the Air District to regulate fine PM as a toxic air contaminant.*

Discussion*:* Air District staff clarified that:

- the California Air Resources Board (CARB) and Office of Environmental Health Hazard Assessment (OEHHA) are the agencies responsible for designating toxic air contaminants,
- the goal of seeking designation of $PM_{2.5}$ as a toxic air contaminant is to allow the Air District greater regulatory latitude, and
- the Air District is already seeking this designation.

Revised RA27*) Continue efforts to designate fine PM as a toxic air contaminant.*

Initial RA28*) Seek authority for the Air District to establish air quality standards for PM.*

Discussion*:* In light of the results of the 2020 Presidential election, Advisory Council members revised this Recommended Action to reflect their anticipation of greater interest in improving air quality standards at the federal level.

Revised RA28*) Advocate for U.S. EPA to establish more stringent air quality standards for PM.*

Initial RA31*) Seek authorization from CARB for stronger at-berth regulations to control emissions from ships that dock at ports and refineries.*

Discussion*:* Air District staff expressed that regulations already require ships to plug in to electricity at port (to curb diesel PM and NOx emissions), and related standards are stringent.

RA31 was deleted*.*

Initial RA32*) PM action plans should include all available technically feasible methods of reducing PM emissions and exposures for stationary, area, mobile, and indirect sources of PM.*

Discussion*:* Advisory Council members acknowledged that not "all" technically feasible methods should be included, but rather the best available methods that are also feasible in terms of cost.

Revised RA32*) PM action plans should include best available methods that are technically and economically feasible for reducing PM emissions and exposures for stationary, area, mobile, and indirect sources of PM.*

Initial RA33*) Legislative approaches to secure additional authority to regulate PM emissions should be considered, e.g. indirect source rule (ISR) or indoor air quality.*

Discussion*:* With input from Air District staff, Advisory Council members determined that the intent of this Recommended Action was already captured elsewhere.

RA33 was deleted.

Initial RA34*) OEHHA and ARB should be petitioned to identify PM as a toxic air contaminant in light of the available health data.*

Discussion*:* Advisory Council members determined that the intent of this Recommended Action was already captured in RA27.

RA34 was deleted.

Initial RA35) *A comprehensive study of indoor air quality should be conducted to better understand the pathways of PM exposure and how people can reduce that exposure through changes in habits.*

Discussion*:* Air District staff provided examples of other agencies that would be better positioned to conduct such a study and suggested that the Air District could have a role in communicating the resulting information.

RA35 was deleted.

Initial RA36*) PM action plans should include non-traditional partners and approaches such as county health officials, health care providers, and methods of improving indoor air quality. (This could provide added protection during episodic events such as wildfires and facility incidents.)*

Discussion*:* Air District staff clarified that the Air District is already taking the approach described in the Recommended Action.

RA36 was deleted.

INPUT FROM PUBLIC COMMENT

Jed Holtzman of 350 Bay Area, who was given additional time by the Advisory Council to complete his comments, made the following arguments for changes to the Recommended Actions:

- RA1 — Especially in light of wildfire PM, [the Advisory Council] need[s] to aim low. Set the target at 8 $\mu g/m^3$ for annual average $PM_{2.5}$ concentration levels.
- RA28 — This authority is needed. Restore the initial version of the Recommended Action calling for the Air District to obtain authority to set air quality standards.
- RA27 — Strike this Recommended Action; the toxics approach is not sought by the affected community and is viewed as "incredibly problematic."
- RA14 — Strengthen the mandate to achieve all-electric in homes in order to combat dire indoor air quality problems.
- RA19 — Do not use the 10-year risk reduction process; it is too slow.
- RA21 — Restore this Recommended Action to prevent the piecemealing of larger projects into smaller components as a loophole to avoid regulation. Cumulative impact is a different concept addressing exposures over time from multiple permitted sources.
- RA15 — Emissions performance is irrelevant if electrification is achieved. A Recommended Action is needed address residential wood smoke.
- RA16 — Strengthen this Recommended Action; call for "maximum feasible action" in the form of robust rules, not just "expand efforts."
- RA18 — Broaden to cover refinery PM in general.

- Overall: "Robustness in recommendations needs to match robustness in the findings."

Charles Davidson, a Hercules resident, also argued for the need to prevent piecemealing of larger projects, pointing to issues that occur when multiple agencies (such as the Air District and county land use authorities) are approving different aspects of one project. He also discussed issues with "industrial, chronic exposures" to indoor air pollution and urged Advisory Council members to remain cognizant of related health impacts in considering standards.

NEXT STEPS

The task of organizing the Recommended Actions into topical categories was assigned to a subcommittee comprising Advisory Council Chair Stan Hayes, Advisory Council member Jane Long, and Advisory Council member Michael Kleinman, who agreed to produce a draft within the week.

The Advisory Council determined that an additional meeting was needed in order to complete deliberations and prepare to submit the final report to the Air District Board of Directors. As the Advisory Council's meeting with the Board of Directors is scheduled for December 16, the additional meeting will need to occur before that date. Air District staff planned to poll Advisory Council members on their availability.

PUBLIC COMMENT SUBMITTED VIA LETTER TO THE ADVISORY COUNCIL

350BayArea

Monday, November 9, 2020

Dear Chair Sinks, Chair Hayes, and Councilmembers,

With so much subject matter to discuss in your meetings, there's no time for pleasantries in three minutes (or six) of public comment, but thank you for your time and thought in service of working through these issues of behalf of the Air District and the health of Bay Area residents. As the primary community stakeholder at the agency, whose staff and members have attended an unfathomable number of Air District policy meetings for the last seven years, and which takes the Air District's success very seriously, we greatly appreciate your serious attention to these serious issues.

Below are some of the comments I made in your November 9 meeting, submitted at your request. I hope they are of help as you work to complete your deliberations.

1. The Council has importantly said in **F1** that, where the Air District has authority, it needs to move quickly to take maximum feasible action. This is the critical kernel coming out of the Council's findings, and this urgency could usefully be carried over to the Recommended Actions section. Advocating for other entities to take an action or seeking funding to pass through, while important secondary parts of the agency's toolkit, do not approach the Air District's core responsibility to meet its public health mission and its core authority under state law to achieve it.

   Demonstrably, the Air District does not have as much trouble with these "soft power" sorts of activities as it does meeting its core regulatory responsibility with respect to stationary and area sources. The dynamic of agency staff actively arguing in your meetings against many of the components and legal frameworks that would make up "maximum feasible action" is a difficult and unfortunately familiar one, but it's important to base recommendations on what is required, not what existing staff feels like doing. It is also important to remember that the policy-making authority of the Air District falls to its elected Board of Directors and not its staff.
2. Especially in light of the huge wildfire PM load we can expect, we need to aim low when setting our targeted concentration from controllable pollution. An 8 mcg/m3 annual average limit + ~4 mcg/m3 annual average contribution from wildfire smoke would still equal 12 mcg/m3, the federal standard that is so injurious to health that it spurred the EPA ISA process and the foundational discussions of this Advisory Council process. So for the purposes of **RA1** and its own associated PMRS, we would suggest leaving the 10 mcg/m3 limit out and focusing on setting the target "as low as 8 mcg/m3 annual average."
3. The recommendation in **RA28** that the District seek authority from the state to set its own tighter air quality standards is critically important, notwithstanding staff's attempts to steer the Council away from it. Setting an air quality standard requires (1) actually making a plan to meet it, (2) taking "all feasible actions" to meet the standard, and (3) reporting in detail about why you didn't meet it and what exactly you are going to do to meet it. It is precisely this robust planning, robust implementation, and robust accountability that the agency's counsel described in your meeting as "additional regulatory overhead" when he said having the authority "doesn't really add much except additional regulatory overhead."

   As far as robust planning, we heard for the first time at your meeting that staff does not intend to develop a comprehensive PM reduction plan—news to the community members who have driven this

PM process at the District beginning in late 2018. As far as robust implementation, we also saw staff at the meeting advise weakening or striking many of the most actionable recommendations that were originally included under Rules, Permitting, and Authority. And as far as robust accountability, there is certainly no mechanism to assess compliance, engage in adaptive management, and ensure public accountability—nor will there be with a loosey-goosey "target" that the Air District will unofficially set.

Setting a PM standard, being in non-attainment of that standard, and being forced to take "all feasible measures" to address the problem is what is required to shake the agency out of its torpor. Our proposals on PM regulation and discussions with supportive board members beginning two years ago led to this Council proceeding, and even after constant engagement over that time, staff is still attempting to minimize the amount of additional work they will need to do. A little tough love and effective public oversight are overdue.

4. Relatedly, the approach in **RA27** of regulating PM like a toxic air contaminant will be useful for getting at local sources that a regional standard would not address, but will *not* be sufficient on its own to meet a meaningful emissions reduction goal. Our invited presentation to the Council at your May 2020 meeting laid out in detail the agency's stunning and singular failure to implement its hallmark rule purporting to use health risk as a legal framework and forcing mechanism (Rule 11-18). When staff says they want to regulate PM like a toxic , they are saying they intend to use this approach for all regulatory emissions reductions. This would be demonstrably disastrous. Among other glaring flaws, no reductions in deadly pollution—responsible for 2,000 to 3,000 early deaths per year in the region—would begin for several years. How the agency can legally achieve needed PM reductions has been a huge and central focus of staff's communication with the public over this two-year discussion, but this subject was glaringly absent in your meeting today. We need a regional *and* a local approach, as your findings indicate. Effectuating this requires not only regulating PM further like a toxic but also further as a criteria pollutant, which the standard-setting authority discussed in the last point would allow.

5. The Air District is already discussing mechanisms to get rid of natural gas in new construction with 350 Bay Area, Building Decarbonization Coalition, Rocky Mountain Institute, and others. We encourage you to re-strengthen **RA14** and recommend that the District use all its authority to push building decarbonization based on air quality impacts. Staff indicated today that a subset of appliances fall under their existing outdoor air quality authority, however the Board of Directors has received a presentation indicating more NOx is generated indoor from natural gas appliances than is generated from all power plants in the state, with definite impacts to health, and additional standard-setting authority would fill in the gaps here that were causing staff to tiptoe today around pushing an zero-emissions building environment.

6. **RA15** on energy efficiency seemed unnecessary if RA14 is implemented appropriately. Improvements to fossil fuel infrastructure at this late date should primarily employ replacement with feasible zero-emission alternatives. Expanding the discussion in RA14 from new construction to include renovations, replacements, changeouts, etc., will effectively take care of iterative efficiency improvements, reduce GHGs and morbidity, and help reduce over time the looming stock of building retrofits that will need to be done.

7. Woodsmoke has been dropped from this discussion at some point; we're not sure when. But including further controls on wood-burning is still warranted, especially given that we're breathing woodsmoke for weeks to months each year at this point. Please re-include policy recommendations to reduce woodsmoke and any other significant sources of PM in the region.

8. **RA16** is an example of one fairly nondescript rule among *many* that will be required to reduce emissions instead of simply talking about it. It is uncontroversial that this rule needs to be expanded, but as with many, the language was weakened incommensurate with the urgency called for in your

findings and in F1. We need so many rules, robustly implemented and robustly enforced, to meet this challenge—and your recommendations shouldn't shrink away from this inconvenient truth.

9. **RA18** could usefully be broadened to include rules on all significant sources of refinery PM. The communities bordering these facilities are the definition of environmental justice communities, whose long-disproportionate impacts to health and life must be addressed. Even now, heated discussions are underway at the agency about amendments to Rule 6-5 on refinery fluid catalytic cracking units, the largest single source of PM at the facilities. Sulfur is just one element, no pun intended.
10. The site-wide health risk approach in **RA19** is essentially a Rule 11-18 for PM. Again, see our May presentation to the Council and Air District staff's own reports to the Board of Directors on this rule for an illustration of its unfortunately fatal flaws. This is a losing approach to addressing this critical and deadly pollution burden, and it's one the community will not support.
11. In regards to **RA20** and **RA21**, cumulative impact and piecemealing are definitely two separate issues of permitting. Cumulative impact refers to the impacts to overburdened communities over time. Currently, an air permit is approved if it meets its own internal conditions, regardless of whether that new emissions source is the first significant source on the block or the hundredth. Addressing cumulative impact in permitting in RA20, which Air District staff says they are pursuing, would take the actual spatial and temporal emissions environment into account for the benefit of giving overburdened and disproportionately impacted communities an overdue break.

    Piecemealing, on the other hand—which Air District staff has no intention of addressing for fear of upsetting the fossil fuel industry and other deep-pocketed parties—refers to separating a large project into smaller pieces to avoid regulation of various kinds, including Air District permit rules and emissions regulations. People live and die based on whether Air District legal staff classifies a refinery proposal as two or more "minor modifications" instead of one "major modification," to use just one example.

Thank you again for the extra speaking time at your meeting and for the consideration of these comments as your pursue and complete your deliberations. The Advisory Council proceedings on PM that are winding to an end here are well ahead of the discourse at the state level, to say nothing of the federal, and relying on those levels of government to lead on PM reduction is misplaced. The Air District can and should lead with maximal feasible and innovative action on PM to save lives, address its mission, and do so in a timely manner. Your strong recommendations will be key to the region's success.

Best regards,

Jed Holtzman

Senior Policy Analyst

Particulate Matter:
Spotlight on Health Protection

Appendix C: Symposium Summaries and Presentations

Particulate Matter:
Spotlight on Health Protection

Symposium Summary: Health Effects and Exposures and Risk

October 28, 2019

BAY AREA AIR QUALITY
MANAGEMENT DISTRICT

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Executive Summary

On October 28, 2019, the Bay Area Air Quality Management District (Air District) convened a symposium, at the request of its Advisory Council, to obtain input from leading experts on the best available science concerning impacts of particulate matter (PM). The morning panel focused on PM health effects; the afternoon panel focused on PM exposure and risk. After hearing from national and state air quality experts on the panels and from community members during public comment periods, the Advisory Council drafted the following Sense of the Advisory Council statement:

> **The current PM standards are not adequately health protective. Further reductions in particulate matter will realize additional health benefits. We ask the Air District staff to bring forward with urgency options within the legal authority of the Air District that would further limit PM exposure, especially in high-risk communities.**

This consensus was reached upon consideration of information presented by the panelists and public commenters demonstrating: adverse health effects of PM, including mortality, at concentrations below the current standard; disproportionate burden of PM exposure and risk on disadvantaged communities, including those within the Air District; and emerging evidence of the health impact of ultrafine particles (UFP) and wildfires, both of which are understudied.

PM Health Effects

Draft PM ISA. Jason Sacks**,** Project Lead on the Particulate Matter Integrated Science Assessment (PM ISA) and Senior Epidemiologist at the Environmental Protection Agency's (EPA) National Center for Environmental Assessment, reviewed the structure and findings of the Draft PM ISA (https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter). His presentation demonstrated that PM causes more health problems than previously known, at lower concentrations than previously known, and disproportionately affects vulnerable populations. In particular, the Draft PM ISA found new causal or likely-to-be causal associations between nervous system effects and long-term exposure to $PM_{2.5}$ and, independently, to the portion of $PM_{2.5}$ considered to be ultrafine particles (UFP), and between cancer and long-term exposure to $PM_{2.5}$. Children and non-white populations are at increased risk of adverse health effects of PM, and there is no evidence of a concentration threshold below which effects are not observed.

Mechanisms of PM impact. Advisory Council Vice Chair Michael Kleinman, Professor of Environmental Toxicology at UC Irvine and Co-Director of the Air Pollution Health Effects Laboratory, focused on the formation, composition, and mechanistic health effects of PM and new insights from his research concerning the toxicity of PM. He discussed how the connection between PM and health effects can be traced mechanistically, with oxidative stress from biological reactions to PM leading to inflammation, cell death, and cardiovascular events. He also discussed how the toxicity of PM may be attributable to its coating rather than its core, although metals in the core can also produce health effects.

PM burdens and wildfire impacts. Dr. John Balmes, Professor of Medicine at UC San Francisco, Professor of Environmental Health Sciences at UC Berkeley, and Director of the Northern California Center for Occupational and Environmental Health, covered numerous topics associated with particulate matter including sources, effects, challenges with UFP, disproportionate burdens of exposure, and wildfire impacts. His presentation demonstrated that PM exposure leads to a wide range of health problems and disproportionately affects low-income communities and people of color, who suffer cumulative impacts from multiple exposures and disadvantages. In California, exposure to wildfire smoke is associated with increases in health care utilization for both respiratory and cardiovascular problems.

Independent PM Review Panel. Christopher Frey, Chair of the Independent Particulate Matter Review Panel and Glenn E. Futrell Distinguished Professor of Environmental Engineering at North Carolina State University, explained how recent changes to the review process for the federal National Ambient Air Quality Standards (NAAQS) led to the formation of the Independent Particulate Matter Review Panel. He summarized the conclusions of that panel:

- The scientific evidence for $PM_{2.5}$ health effects is robust.
- The current $PM_{2.5}$ standards are not adequately protective of public health.
- The annual standard should be lowered to 10 micrograms per cubic meter ($\mu g/m^3$) to 8 $\mu g/m^3$ (versus the current 12 $\mu g/m^3$ standard).
- The 24-hour standard should be lowered to 30 $\mu g/m^3$ to 25 $\mu g/m^3$ (versus current 35 $\mu g/m^3$ standard).
- These changes would save thousands of lives.
- The PM_{10} standard should be adjusted downward consistent with these changes.
- There appears to be no threshold; lower levels would produce still greater benefits.
- For African Americans, the relative risk of health impacts from PM is three times higher than for the U.S. as a whole.

<u>PM Exposures and Risks</u>

OEHHA research. Lauren Zeise, Director of the California Office of Environmental Health Hazard Assessment (OEHHA) and Leading Developer of CalEnviroScreen, described some of OEHHA's current research efforts to understand the relationships between specific PM sources and community health outcomes. After explaining that there is great variability in the relationship between PM concentration and health risk, she discussed how OEHHA is conducting biomonitoring studies to track whether biomarkers indicate reductions in risk following reduced air pollution concentrations. These data, along with indoor air samples, questionnaires, activity diaries, and information from GPS trackers, will be combined with source pollution mapping data to determine how exposures are occurring. Dr. Zeise also demonstrated that wildfires are causing PM standards to be exceeded for both 24-hour and annual averages. OEHHA is presently investigating relationships between the 2017 Northern California Wildfires and numerous health outcomes in the area including respiratory, cardiovascular, and neurological problems.

Silver buckshot, not silver bullet. Julian Marshall, Kiely Endowed Professor of Civil & Environmental Engineering and Adjunct Professor of Global Health at the University of Washington, described an approach to reducing health risks from PM involving combined analysis of sources of emissions, concentrations at geographical locations, levels of exposure to different sources of emissions, and racial and income disparities affecting environmental justice. Because PM comes from many sources, he concluded that reducing PM exposure requires many strategies, describing this approach as "silver buckshot, not a silver bullet." With respect to health risks from PM, he demonstrated that income matters, and race matters, but race matters more than income. To get the most "bang for the buck" on health impacts, he argued that interventions should focus on areas where high impact from PM meets high inequity in terms of environmental justice.

Draft PM Policy Assessment. Scott Jenkins, Project Lead on the EPA's review of National Ambient Air Quality Standards for PM and Senior Environmental Health Scientist in EPA's Office of Air Quality Planning and Standards, presented an overview of the approach and conclusions of the EPA's Draft PM Policy Assessment completed in response to the Draft PM ISA. The PM Policy Assessment featured a risk assessment indicating that thousands of lives per year in the U.S. could be saved if annual average $PM_{2.5}$ concentrations are reduced. The assessment included an argument for revising the annual $PM_{2.5}$ standard downward based on the science, as well as a discussion of how retaining the current standard could be justified by placing very little weight on the epidemiological evidence and risk assessment and greater weight on the uncertainties and limitations of the data.

West Oakland Community Action Plan. Phil Martien, Director of Assessment, Inventory, & Modeling for the Air District, described the analysis conducted for the recently completed West Oakland Community Action Plan, the first in a series of community emissions reduction programs that the Air District is developing in response to California's Assembly Bill 617 legislation (AB 617). Per the community's requests, the study took a hyperlocal approach, modeling block-by-block exposures. Disparate exposure levels were seen within West Oakland: the cleanest blocks are experiencing on average 3 $\mu g/m^3$ lower PM concentrations than the most polluted blocks. Sources of PM also differed, with some areas experiencing $PM_{2.5}$ emissions primarily from street traffic and others experiencing the greatest proportion of $PM_{2.5}$ emissions from highways or permitted sources. The West Oakland Community Action Plan demonstrates how hyperlocal modeling can be accomplished, but also highlights the need for other agencies to act, such as California Air Resources Board (CARB), the City of Oakland, and the Port of Oakland, in order to reach community emissions reduction targets.

<u>Public comment</u>

Public comment was taken during two designated periods during the event. The general sentiment expressed by many commenters was, "We need action, not more discussion."

Several people spoke about their personal experiences with toxic emissions in their neighborhoods. The disproportionate impact of air pollution on disadvantaged communities was a central point of focus.

Discussion and Deliberation

The discussion between the Advisory Council and the morning panel focused on cost considerations and the appropriateness of a "no safe level" stance, and broached the topic of recommending Air District priorities, which led to further discussion regarding the monitoring of ultrafine particles. The discussion between the Advisory Council and the afternoon panel was brief and comprised of one question concerning margin of safety considerations in the Draft Policy Assessment (which Dr. Jenkins clarified was the exclusive domain of the EPA Administrator).

The Advisory Council's deliberation followed, resulting in the Sense of the Advisory Council statement presented above. Advisory Council members also expressed interest in further exploring the potential for:

- Treating PM as a toxic;
- Monitoring ultrafine particles;
- Encouraging the State of California to adopt stricter PM standards;
- Ensuring local permits are consistent with the PM standard supported by the science;
- Disaggregating solutions with climate co-benefits, solutions unrelated to climate strategies, and emergencies;
- Identifying strategies to maximize impact or "bang for the buck"; and
- Creating an Air District Implementation Plan.

Next Steps

The Advisory Council will reconvene on December 9, 2019. During that meeting, in response to the Advisory Council's requests, the Air District will present on its current activities to reduce PM exposures, including monitoring of ultrafine particles. It will also discuss additional "options within the legal authority of the Air District that would limit PM exposure, especially in high-risk communities," in accordance with the Sense of the Advisory Council, in order to inform the Advisory Council's advice to the Air District's Board of Directors. The Advisory Council is expected to receive and comment on this symposium summary document during the December 9 meeting.

Planning continues for a second PM symposium focused on community and other stakeholder input and engagement; the event will take place in Spring 2020.

Background

On October 28, 2019, the Bay Area Air Quality Management District (Air District) convened a symposium, at the request of its Advisory Council (Council), in order to obtain input from leading experts on the best available science concerning health effects of particulate matter (PM). Serving as an official meeting of the Advisory Council, which advises and consults with the Air District's Board of Directors and Executive Officer on technical and policy matters, the symposium sought to discuss:

<u>PM Health Effects</u>

- what health effects are observed from PM exposure, including exceptionally high acute PM exposures (e.g., wildfire smoke);
- what biological systems are affected and by what mechanisms;
- what population groups are most at risk; and
- what uncertainties are most relevant.

<u>PM Exposure and Risk</u>

- what the emission sources are that contribute to PM;
- what exposures to airborne PM occur and to whom;
- what health risks are posed by those PM exposures; and
- what subset of sources contribute most to PM risk, particularly in the most highly impacted communities.

The symposium followed several relevant policy developments at the state and federal levels. In California, Assembly Bill 617 passed in 2017 directing the California Air Resources Board and all local air districts to protect communities disproportionally impacted by air pollution. Implementation in the Bay Area Air Quality Management District to date includes the development of a community-led plan for air quality improvement in West Oakland (adopted by the Air District's Board of Directors in October 2019) and an air quality monitoring program for the Richmond area (underway).

At the federal level, staff of the Environmental Protection Agency (EPA) released a Draft Integrated Science Assessment (ISA) for Particulate Matter (PM) in October 2018, followed by a Draft PM Policy Assessment regarding the standard-setting implications of the PM ISA in September 2019. These drafts were submitted for review to the Clean Air Scientific Advisory Committee (CASAC), which provides advice to the EPA Administrator on the setting of national ambient air quality standards. Additionally, a separate, independent response to both EPA draft documents was released in October 2019 by the Independent Particulate Matter Review Panel, whose members served previously on the CASAC PM Review Panel until their dismissal in October 2018 by EPA Administrator Andrew Wheeler.

The timing of the symposium also coincided with the outbreak of the Kincade Fire in Sonoma County and associated evacuations. Additionally, widespread power outages within the Air

District's jurisdiction were intentionally executed by Pacific Gas & Electric (PG&E) as wildfire prevention measures given the dry conditions and high winds. This crisis formed a backdrop to the proceedings.

Particulate matter experts presenting at the event included the lead authors of the EPA PM ISA (Jason Sacks), the EPA PM Policy Assessment (Dr. Scott Jenkins), the Independent Review Panel document (Professor Christopher Frey), and the West Oakland Community Action Plan (Dr. Phil Martien). They were joined by Independent Particulate Matter Review Panel Members Professor Michael Kleinman and Dr. John Balmes, Director of the California Office of Environment Health Hazard Assessment Dr. Lauren Zeise, and University of Washington Professor Julian Marshall. These speakers were organized into a morning panel focused on PM health effects and an afternoon panel focused on PM exposure and risks.

The event, which was open to the public, included two public comment periods. The midday lunch break featured a keynote address by former EPA Administrator Gina McCarthy, who also answered questions from community attendees.

The morning and afternoon panels were each followed by joint discussions between the Advisory Council members and panelists. The event concluded with a brief Advisory Council deliberation.

The event was shared live via webcast, the video archive of which can be viewed at http://baha.granicus.com/MediaPlayer.php?clip_id=6194.

Morning Panel: PM Health Effects

Current State of Particulate Matter Science: Particulate Matter Integrated Science Assessment (Working Draft Conclusions)

Jason Sacks
Project Lead, Particulate Matter Integrated Science Assessment (PM ISA)
Senior Epidemiologist, National Center for Environmental Assessment, EPA

Main takeaway	**PM causes more health problems than previously known, at lower concentrations than previously known, and disproportionately affects vulnerable populations.**

Presentation Summary

Mr. Sacks reviewed the structure and findings of the initial draft of the EPA's recent Particulate Matter Integrated Science Assessment (PM ISA), which aims to provide an updated review of the science in order to assist federal rulemaking. The Draft PM ISA addresses the question:

> *"Is there an independent effect of PM on health and welfare at relevant ambient concentrations?"*

The PM ISA drafters reviewed the body of new research since 2009 including epidemiological studies, animal toxicological studies, and controlled human exposure studies at PM levels analogous to ambient concentrations in U.S. communities.

The Draft PM ISA can be found at https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter.

Health effects. The Draft PM ISA found new causal or likely-to-be causal associations between:

- Nervous system effects and long-term exposure to $PM_{2.5}$ and, independently, to the portion of $PM_{2.5}$ considered to be ultrafine particles (UFP)
- Cancer and long-term exposure to $PM_{2.5}$

The science also confirmed and strengthened the evidence of previously known causal or likely-to-be-causal associations between respiratory, cardiovascular, and mortality effects of both short- and long-term exposure to $PM_{2.5}$. Additional PM exposure associations with metabolic and reproductive effects suggested causality but did not meet the strict criteria for "causal" or "likely-to-be-causal," often due to a limited quantity of data.

At-risk populations. Children and non-white populations are at increased risk of adverse health effects of PM. Further evidence regarded as "suggestive" points to increased health risk for people with low socioeconomic status, overweight and obese populations, people with pre-existing cardiovascular and respiratory disease, and people with certain genetic variants.

Chemical components of PM. The evidence does not indicate that any one specific chemical component of PM is a disproportionate concern over others.

Advisory Council Q&A with Panelist

No threshold. Council Member Rudolph inquired whether any evidence supported a threshold concentration value below which health effects from $PM_{2.5}$ could not be observed. The panelist responded that there does not appear to be any such threshold.

Changes to health effect determinations. Chair Hayes requested further clarification on the new findings from the ISA since 2009, which are outlined above and in Slide 15 of the presentations.

Relevance of animal studies concerning UFP. Council Member Solomon asked if there was any reason to question whether results seen in animal studies concerning UFP would be consistent with human health effects. The panelist replied that the inconsistency was in the size of the particles considered to be UFP. There has not been a consistent metric or definition for UFP, which has limited the ability to draw conclusions.

Publication bias. Council Member Borenstein inquired whether studies with null results were being published; if not, there may be a concern that the presentation represented only the fraction of research that observed positive associations with health effects. The panelist clarified that this concern drove the decision to focus on multi-city studies in order to ensure that null results would be incorporated.

Wildfires and sub-daily exposures. Given the Kincade Fire that was burning at the time of the event, Chair Hayes inquired about the influence of sub-daily exposures to high levels of PM. The panelist responded that there are some controlled human exposure studies that would be equivalent to a person walking along a busy road, during which some changes in cardiac and lung function have been observed, but sub-daily studies are scarce and he was not aware of research that would be directly relevant to wildfire exposures.

Particulate Matter: A Complex Mixture that Affects Health

Michael Kleinman
Professor of Environmental Toxicology, University of California, Irvine
Co-Director, Air Pollution Health Effects Laboratory

Professor Kleinman is also Vice Chair of the Air District's Advisory Council.

Main takeaways	**PM can be mechanistically and causally linked to cardiovascular health effects. The toxicity of PM may be more attributable to its coating than its core, although metals in the core can also produce health effects.**

Presentation Summary

Professor Kleinman's presentation focused on the formation, composition, and mechanistic health effects of PM and new insights from his research concerning the toxicity of PM.

Basic PM process. A key source of PM is the combustion of fossil fuels. After these fuels break down during combustion, they cool, become radicalized, and agglomerate. Additional chemicals adhere to these particles and can form highly toxic compounds that may include contaminants such as chlorine, bromine, and metals. When these particles are inhaled and enter the respiratory tract, they can react with proteins and fluids in the lungs and release highly reactive free radicals, causing chemical imbalances throughout the body. If these free radicals overwhelm the body's antioxidant self-protection capabilities, the process can result in inflammation, cell death, and organ failure. Because oxidative stress can oxidize lipids in the blood, it can also lead to the development of atherosclerotic plaque and coagulation factors that can contribute to cardiovascular events such as stroke and heart attack.

"The icing, not the cake." Professor Kleinman's laboratory experimented with removing the organic coating from ambient air particles to which animals were exposed to determine whether, in the words of Chair Hayes, the problem was "the icing or the cake." They found that stripping the particles of their organic coating appeared to mitigate their toxicity.

Additional key points:

- Data limitations concerning chemical components. $PM_{2.5}$ total mass is regarded as a more relevant concern than specific components within it, but this may be due to the much smaller database available for chemical components than for $PM_{2.5}$ as a category.
- Measurement challenges. Ultrafine particles are difficult to measure and monitor because they have almost no mass.
- Risks for California. Sunlight, which is plentiful in California, is involved in the formation of pollutants. In addition to PM, health is also affected by air pollutants such as ozone, which is a strong oxidant. The combined effects of PM and ozone, which can be

experienced in the same day, may cause high levels of oxidative stress. Additionally, Professor Kleinman's research indicates that particles formed on warmer days result in worse health effects than those formed on cooler days, which portends additional problems in an era of climate change.

Advisory Council Q&A with Panelist

Incomplete combustion and control technology. Council Member Long inquired whether UFP resulted from incomplete combustion and whether newer technologies were effective in controlling their formation. The panelist responded that to his knowledge all combustion resulted in the formation of ultrafine particles (along with other particles). He noted that although modern diesel engine afterburner controls denuded particles in a manner similar to his animal toxicology experiments, they also produced high amounts of UFP.

Greenhouse gas impacts. Council Member Rudolph asked whether the process of stripping components from PM would change the release of carbon dioxide from combustion, emphasizing that "climate change is the greatest existential threat to human health right now." She questioned whether targeting the toxicity of the results of combustion should be a goal rather than trying to reduce combustion itself in order to reduce greenhouse gas emissions. The panelist shared his view that in the short-term "we can improve public health by mitigating what we're making right now," while in the long-term pursuing strategies to reduce reliance on fossil fuels.

Particulate Matter Health Effects: What Do We Know and What Do We Still Need to Know?

John Balmes, M.D.
Professor of Medicine, UC San Francisco
Professor of Environmental Health Sciences, UC Berkeley
Director, Northern California Center for Occupational and Environmental Health

Main takeaways	**PM exposure leads to a wide range of health problems and disproportionately affects low-income communities and people of color, who suffer cumulative impacts from multiple exposures and disadvantages. In California, exposure to wildfire smoke is associated with increases in health care utilization for both respiratory and cardiovascular problems.**

Presentation Summary

Dr. Balmes covered numerous topics associated with particulate matter (PM) including sources, effects, challenges with UFP, disproportionate burdens of exposure, and wildfire impacts.

Sources of PM. PM derives not only from combustion particles, but also from crustal and biological sources; for example, road dust is a significant source of PM. Dust particles may carry biological components that can cause health effects.

Health effects. In addition to re-emphasizing the health effects covered in Mr. Sacks' and Professor Kleinman's presentations, Dr. Balmes further noted:

- the smaller the particle, the farther it travels into the body, with some PM particles small enough to enter the bloodstream and even cross the blood-brain barrier;
- $PM_{2.5}$ is associated with increased risk of metabolic effects, including diabetes;
- fetal $PM_{2.5}$ exposures can result in low birth weight, pre-term birth, and changes in gene expression; and
- brain inflammation from PM can affect both ends of the life spectrum - neurodevelopment and neurodegeneration.

Challenges with UFP. As mentioned by previous presenters, because UFP is not regulated independently from other $PM_{2.5}$, there is limited monitoring, which presents challenges for epidemiological research, although toxicological studies suggest UFP is a high-risk hazard. Further, innovations designed to reduce climate change impacts, such as gasoline direct injection, can result in higher UFP emissions.

Disproportionate burdens and cumulative impacts. People of color and people with low socioeconomic status are more likely to be exposed to PM, and the risk from these exposures is compounded by the lack of health-promoting resources in these communities such as health care, fresh produce, and green spaces. Dr. Balmes shared the example of Richmond, CA, which is within the Air District's jurisdiction. People living in the Liberty/Atchison Villages in Richmond are next to the railyard, near the freeway, next to the General Chemical Corporation (which recently had a serious accident), and downwind from the Chevron Refinery. Stating, "This cumulative risk concept is something that we need to be including in our thinking about air quality management," Dr. Balmes also noted that the Air District is a leader in this regard.

Wildfires. While acknowledging that "we need to know more than we currently do," Dr. Balmes asserted that there is a well-known association between wildfires and increased health care utilization for people with respiratory conditions such as asthma and chronic obstructive pulmonary disease. Additionally, a recent California study associates wildfire smoke with cardiovascular events including heart attack, stroke, and heart failure.

Advisory Council Q&A with Panelist

Wildfire contribution to cumulative impact. Council Member Rudolph asked whether wildfires should be understood as an additional layer of cumulative impact. The panelist responded that although he hadn't considered that framing, it was accurate, as people with lower socioeconomic status are those most likely to be without the means to relocate during wildfires. Rural agricultural workers are one example of a community that may be working outdoors despite poor air quality from wildfires. Council Member Rudolph asked whether it was accurate to say, "It's even more important to reduce our baseline exposures because we know these acute exposures are going to be happening more frequently" due to climate change, or if the two issues of baseline and acute exposures should not be viewed as interrelated. The panelist asserted that Council Member Rudolph's statement was accurate.

Bay Area studies? Referring to slide 76, which mapped Los Angeles county data comparing the distribution of non-white people and people living in poverty alongside the distribution of cumulative air quality hazard, Council Member Solomon asked whether the same analysis could be performed for the Bay Area. The panelist replied that although he was not aware of such an analysis having been performed, it should be possible. He indicated that he would speak with an expert he believed to be capable of executing the task.

Recent Developments in the Scientific Review of the National Ambient Air Quality Standards for Particulate Matter

Christopher Frey
Chair, Independent Particulate Matter Review Panel
Glenn E. Futrell Distinguished Professor of Environmental Engineering, North Carolina State University

Main takeaways	**The federal administration truncated the National Ambient Air Quality Standard science review process and purged the Clean Air Scientific Advisory Committee (CASAC) and the supporting CASAC PM Review Panel of critical scientific expertise. The scientists who were dismissed from the CASAC PM Review Panel continued their review work independently and found that the current PM standards are insufficient to protect public health.**

Presentation Summary

Professor Frey explained how recent changes to the review process for the federal National Ambient Air Quality Standards led to the formation of the Independent Particulate Matter Review Panel. He then summarized the conclusions of that panel, which he leads.

Federal PM Review

Process: The scientific review process that for four decades involved an iterative sequence of assessments flowing from science to policy has been severely abridged. Notably, the EPA's PM Policy Assessment (PA) must now be finalized without reviewing the EPA's final PM Integrated Science Assessment (ISA). Additionally, members of the Clean Air Scientific Advisory Committee (CASAC) PM Review Panel were dismissed, leaving the current CASAC without, by its own admission, the necessary expertise to respond to the documents. Acknowledging the good work accomplished by EPA staff in completing the Draft PM ISA and Draft PM PA in difficult circumstances, Professor Frey emphasized the need for the Air District "to look elsewhere than the EPA's Chartered Clean Air Scientific Advisory Committee" for guidance on PM science review.

Findings: As of October 25, 2019, the remaining six CASAC members were split 4-2 on their national ambient air quality standards (NAAQS) recommendations, with the majority supporting retaining all current standards.

Independent Particulate Matter (PM) Review Panel

Process: Led by Professor Frey, the scientists that were dismissed from the CASAC PM Review Panel continued to meet, without compensation, to complete the public service to which they had committed as CASAC PM Review Panel members. With logistical support from the Union of

Concerned Scientists, the Independent PM Review Panel met for two days in October 2019 and developed a consensus report that was sent to the EPA Administrator. The report and the video-recorded proceedings can be accessed at https://ucsusa.org/meeting-independent-particulate-matter-review-panel.

Findings: The scientific evidence for $PM_{2.5}$ health effects is robust. The current $PM_{2.5}$ standards "are not protective of public health, not even close."

- The annual standard should be lowered to 10 µg/m^3 to 8 µg/m^3 (versus the current 12 µg/m^3 standard)
- The 24-hour standard should be lowered to 30 µg/m^3 to 25 µg/m^3 (versus the current 35 µg/m^3 standard)
- These changes would save thousands of lives
- The PM_{10} standard should be adjusted downward consistent with these changes
- There appears to be no threshold; lower levels would produce still greater benefits
- For African Americans, the relative risk of health impacts from PM is three times higher than for the U.S. population as a whole

See Slides 102 and 103 for Professor Frey's rapid-fire answers to questions posed by the Air District.

Advisory Council Q&A with Panelist

Response to Independent PM Review Panel. Council Member Long asked whether the Independent PM Review Panel received a response from the EPA Administrator or had been mentioned in the press. The panelist replied that the Administrator had not responded, but may not yet have received the report. However, the Independent PM Review Panel also submitted their report as public comment to CASAC, and several CASAC members referred to the report during their deliberations on October 25, 2019. There has been some press coverage of the Independent PM Review Panel, for example in the *Guardian* and *Rolling Stone*.

Safety at 8 µg. Council Member Solomon expressed the concern that, if there is no threshold below which health effects cannot be observed, 8 µg/m^3 cannot be regarded as safe, particularly for vulnerable individuals. The panelist replied that the recommendation is given within the policy context of national ambient air quality standards (NAAQS) and is intended to support a standard that could withstand judicial review. The number is based on the available science, which focuses on ambient air pollution levels observed in epidemiological studies. The Clean Air Act requires that the standards protect public health "allowing an adequate margin of safety," which should protect the general population and at-risk groups, but will not necessarily protect every individual.

The post-presentation Q&A segued into the general discussion between the Advisory Council and the PM Health Effects panel. This discussion is described in the following section.

PM Health Effects: Discussion Summary

The discussion between the Advisory Council and the morning panel focused on cost considerations and the appropriateness of a "no safe level" stance and broached the topic of recommending Air District priorities, which led to further discussion regarding UFP.

Cost considerations and appropriateness of "no safe level" language. Council Member Borenstein expressed discomfort with the language of "no safe level" of PM, emphasizing the need to assess the costs, including health costs, of implementing more stringent standards and using the analogy of motor vehicles to demonstrate that all areas of safety concern must accept some risks. Professor Frey responded that the U.S. Supreme Court's interpretation of the Clean Air Act expressly forbids cost considerations in setting National Ambient Air Quality Standards and stated that voluntary activities such as driving should not be equated to the involuntary act of breathing. He also clarified that the conclusion "there is no evidence of a threshold" is not in itself an argument for banning all particulate emissions. Dr. Balmes addressed the topic from his perspective as a physician member of the California Air Resources Board (CARB). He clarified that whereas CARB does consider economic impacts, the Independent PM Review Panel, following the procedures that had until recently governed CASAC, was restricted from mingling health and economic concerns. He also emphasized that while the most precautionary stance would consider levels below 8 $\mu g/m^3$, the lack of data on lower levels of exposure makes it appropriate to recommend 8 $\mu g/m^3$ for a present limit. In response to a question from Council Member Solomon, Professor Frey clarified that this 8 $\mu g/m^3$ recommendation did take into consideration the increased sensitivity to pollution impacts of African American populations.

Recommending Air District priorities. Chair Hayes asked for guidance in identifying the most important areas of focus for the Air District, given the science and the particular challenges for the area, including wildfires. Dr. Balmes emphasized the need for community-level monitoring in accordance with AB 617 to identify air pollution "hot spots" and hypothesized that black carbon, a form of PM, may be a vital concern for these communities. He also expressed support for monitoring ultrafine particles (UFP) and collecting epidemiological data concerning wildfires. Council Member Long emphasized the need for a strategic plan.

Ultrafine particles. The discussion of UFP continued with Mr. Sacks underscoring that while animal toxicological studies show effects of UFP, little is known about UFP's effects on the human population. One challenge for such research is that particles emitted as UFP may not stay in that size range. He further noted that UFP are contained within $PM_{2.5}$ and efforts to control $PM_{2.5}$ therefore may also bring down UFP concentrations. In response to Chair Hayes' requests for guidance regarding UFP, Professor Frey suggested establishing monitoring stations in carefully selected locations as a long-term strategy and public education/consumer ratings regarding automobile ventilation and filtration systems as more immediate tactics. Professor Kleinman noted that there may be an opportunity for regulation to stimulate innovation with respect to decreasing UFP emissions and that the European Union already requires vehicles to share "particle numbers" regarding in-cabin air quality.

Afternoon Panel: PM Exposure and Risk

Exposure and Risk Panel
Particulate Matter: Spotlight on Health

Lauren Zeise
Director, California Office of Environmental Health Hazard Assessment
Leading Developer, CalEnviroScreen

Main takeaways	**There is a high degree of variability among individuals in the relationship between PM exposure concentration and health risk. OEHHA is pursuing research to determine the most important sources of air pollution with respect to health effects. Wildfires are causing PM standards to be exceeded for both 24-hour and annual averages.**

Presentation Summary

After explaining how health risks from PM can vary, OEHHA Director Zeise described some of OEHHA's current research to understand the relationships between specific PM sources and community health outcomes. She also shared some initial data on PM levels from wildfire.

Variability. There is a high degree of variability in concentration-response relationships relating PM exposure concentration to resulting health risks, due to multiple factors including:

- variable individual vulnerability (e.g., health status, genetic factors, demographic factors)
- variable doses at a given concentration (e.g., breathing rates, other physiological factors)
- variable concentrations within a location (e.g., in West Oakland, can be five times higher)

Given this variability, one way to get the most "bang for the buck" is to focus on improving air quality in communities with the highest exposures and highest vulnerabilities.

Current research at OEHHA. Several relevant studies are underway in alignment with AB 617 that will provide valuable input to PM risk management efforts. A key feature of these studies is biomonitoring to determine whether biomarkers indicate reductions in health risk following reduced air pollution concentrations. For example, the East Bay Diesel Exposure Project is a pilot study measuring exposure to diesel exhaust among community residents. This project collects urine samples in addition to indoor air samples, questionnaires, activity diaries, and information from GPS trackers. These data collected from residents will be combined with source pollution mapping data to determine how exposures are occurring.

Wildfires. PM concentrations during the 2017 Napa Wildfire reached 24-hour averages close to 200 µg/m^3 and one-hour averages above 300 µg/m^3 in some areas. In West Oakland, wildfire impacts on PM have driven annual averages above the national standard, to 12.9 $\mu g/m^3$ in 2017 and 14.4 $\mu g/m^3$ in 2018. OEHHA is presently investigating relationships between the Napa Wildfire and numerous health outcomes in the area including respiratory, cardiovascular, and neurological problems.

Advisory Council Q&A with Panelist

Wildfire research outcomes. Chair Hayes asked if any preliminary health outcome results could be shared from the Napa Fire study, to which the panelist replied that she could not yet share results but expected to do so in the near future. Chair Hayes also asked if OEHHA would be including other years in the study. The panelist replied that while the Napa Fire study is a stand-alone project, the OEHHA epidemiology team has also been involved in a study of primates (macaques) in captivity that tracks outcomes to exposure to wildfires that occurred in 2008. This natural experiment of mother-infant pairs indicates that the exposure resulted in impacts on lung function and immunological markers. Chair Hayes remarked that such findings were consistent with studies in Southern California indicating issues with lung function in children.

Communicating importance of sub-daily exposures. Council Member Borenstein introduced the topic of communicating with the public about risks and precautions, citing the example of a group of teenage girls, presumably a high school track team, who were running, outdoors, while a nearby wildfire caused the air quality index (AQI) to be over 150. The panelist agreed that there is a need for more effective communication strategies and highlighted the misconception that filtration masks allow the wearers to safely exercise outdoors. She referenced a forthcoming meeting in Sacramento in April that will bring together representatives from OEHHA, EPA, Center for Disease Control (CDC), National Institute of Health (NIH), and other agencies to specifically discuss how to advise the public with respect to filtration.

Approaching PM as a non-threshold contaminant. Council Member Solomon inquired about the process for quantifying risk if PM is approached as a non-threshold contaminant. The panelist replied that while it was a difficult task that would involve creating estimates of risk that would differ across communities, it can be done and she anticipates that "working together we can come up with approaches to implement pretty soon."

Location- and source-specific strategies: Consider impact, marginal impact, and environmental justice

Julian Marshall
Kiely Endowed Professor, Civil & Environmental Engineering, University of Washington
Adjunct Professor, Global Health, University of Washington

Main takeaways	**Reducing PM requires many strategies: "silver buckshot, not a silver bullet." With respect to risks, income matters and race matters, but race matters more than income. To get the most "bang for the buck" on health impacts, focus on areas where high impact meets high inequity.**

Presentation Summary

Professor Marshall described an approach to reducing health risks from PM involving combined analysis of sources of emissions, concentrations at locations, levels of exposure to different sources of emissions, and racial and income disparities affecting environmental justice.

Many sources of PM. $PM_{2.5}$ comes from many sources, and not only from primary emissions but also through formation of $PM_{2.5}$ in the atmosphere from other compounds. No one single source is dominant. At the national level, several sources make up a substantial fraction of emissions, including fuel combustion, agriculture, road dust, and residential wood burning. However, there are many other meaningful contributors and therefore tackling $PM_{2.5}$ will require multiple strategies.

Intake fraction in California. When the levels of emissions from different sources are combined with the percentage of those emissions that are inhaled, relative contributions to exposure can more clearly be seen. In California, industrial emissions and on-road mobile sources are particularly high contributors to $PM_{2.5}$ exposure. Importantly, this conceptualization makes clear that emissions reductions are not all equal in impact. For example, reducing one ton of emissions from on-road mobile sources will have greater impact than reducing one ton of emissions from industrial sources because the former category has a higher intake fraction.

Race and income disparities. In California, white people and wealthier people are least exposed to pollution, and the racial difference is more predictive than the income difference. Looking at patterns of consumption, it is also evident that white people are the greatest consumers of the products of polluting activities despite being the least exposed to the resulting pollution.

Mobile measurements and low-emission zones. Dr. Marshall described mobile PM measurement technology as "really promising" for identifying local pollution hotspots and pointed to Google and Aclima as innovators. He also described the policy tool of "low-emission zones" that have been used around the world, although not yet in the U.S., to reduce risks for vulnerable populations subjected to high PM concentrations. Even if some polluting activity relocates outside the zone, positive health outcomes can still be achieved with this strategy.

Advisory Council Q&A with Panelist

How much pollution comes from local sources? Council Member Long inquired how much of the contaminant load in West Oakland (depicted in the panelist's slide showing the results of mobile measurement) could be attributed to local versus regional sources. The panelist replied that the study did not investigate sources and deferred to Phil Martien, the final presenting panelist, to address the question of local versus regional contamination affecting West Oakland. (Dr. Martien's presentation revealed that the majority of $PM_{2.5}$ in West Oakland comes from regional sources; see Slide 198.)

Air District authority. In response to the panelist's question about the Air District's powers, Council Member Borenstein clarified that the Air District regulates stationary but not mobile sources and does not have the power to impose prices or taxes. Although the Air District does impose fines on a limited basis, these can only recover the costs of doing business, and emitters are not required to assume the costs of pollution below the standard. He went on to advocate for the Air District to "lobby Sacramento" for the authority to impose prices to help overcome a situation he described as "trying to make policy with one arm tied behind our back."

Other beneficiaries of polluting activities. Referring to the panelist's analysis of the drivers of pollution, which focused on consumption, Council Member Borenstein commented that additional beneficiaries of polluting activities should be considered: shareholders and workers.

Review of the National Ambient Air Quality Standards for Particulate Matter: Overview of the Draft Policy Assessment

Scott Jenkins
Project Lead, EPA review of National Ambient Air Quality Standards for PM
Senior Environmental Health Scientist, Office of Air Quality Planning and Standards, EPA

Main takeaways	**New studies available since the previous NAAQS review strengthen evidence of serious $PM_{2.5}$ health effects, including premature death, and add additional health concerns. Available scientific information calls into question the adequacy of the public health protection afforded by current standards. Risk assessment results show that reducing PM to alternative standard levels below the current standards would achieve significant additional health benefits, including thousands of lives spared per year in the U.S. Alternatively, retaining the current standards would require placing "little weight" on that information.**

Presentation Summary

Dr. Jenkins presented an overview of the approach and conclusions of the EPA's Draft PM Policy Assessment completed in response to the agency's Draft PM Integrated Science Assessment. He explained that the PM Policy Assessment is intended to serve as a bridge between science and rulemaking, which is expected to take place by the end of 2020. The assessment included an argument for revising the annual $PM_{2.5}$ standard downward based on the science, as well as a discussion of how retaining the current standard could be justified by placing little weight on the epidemiological evidence and risk assessment and greater weight on the uncertainties and limitations of the data.

Focus on "typical" exposures. The NAAQS review process focuses on exposures that represent the middle of the U.S. air quality distribution curve, rather than its extremes. In most U.S. locations, the annual standard is the controlling standard. Epidemiological data is not very informative with respect to the impact of 24-hour exposures on the upper end of the concentration distribution curve, and sub-daily (2-hour) controlled human exposure studies correspond to concentrations considered to be outside the typical distribution curve. The implication of this focus is that the review does not inform analysis of conditions analogous to those occurring during California wildfires.

Pseudo-design values and hybrid modeling. The review examined health effects seen in areas for which PM monitoring data could be used to calculate whether the area's air quality would have met the current standards. This "pseudo-design value" approach approximated the design value statistics used to describe air quality relative to the NAAQS. The review also examined hybrid modeling studies that incorporated not only air quality monitoring but also a range of other data including satellite imagery and land use and transportation information.

Risk Assessment. The risk assessment considered likely mortality outcomes if national air quality was to "just meet" the current 12 µg/m^3 standard in comparison to "just meeting" 11, 10, and 9 µg/m^3. Although estimates differed according to the study being used and whether a primary or secondary PM-based modeling approach was employed, the overall implication was that thousands of lives would be spared at lower concentrations.

Conclusions. The Draft PM Policy Assessment states that "The available scientific information can reasonably be viewed as calling into question the adequacy of the public health protection afforded by the current annual and 24-hour primary $PM_{2.5}$ standards." This conclusion relies on the long-standing body of health evidence, strengthened in the latest review, and risk assessments indicating that current standards allow for thousands of $PM_{2.5}$-associated deaths per year at concentrations above 10 µg/m^3. However, the assessment also states that a conclusion that current standards are sufficient could be reached if very little weight is placed on the large body of epidemiological evidence, particularly the newly available studies regarding lower concentrations, and more weight is placed on uncertainties in the literature.

Advisory Council Q&A with Panelist

Wildfires excluding Bay Area from risk assessment. Chair Hayes asked for clarification on why the Bay Area was not included in the risk assessment. The panelist responded that the assessment aimed to simulate impact from anthropogenic sources, so the focus was on areas for which that adjustment could reliably be done using available data. The implication appeared to be that it was difficult to disentangle wildfire effects from anthropogenic effects.

Lessons for areas controlled by 24-hour standard? Given that the focus of the Draft PM Policy Assessment was on areas in which the annual standard is controlling, Chair Hayes asked what the Air District, which experiences 24-hour concentrations well above the standard during wildfires, should take away from the analysis. The panelist acknowledged that the epidemiology driving the assessment is focused on the middle of the air quality distribution and does not offer many insights for areas experiencing very high 24-hour and sub-daily concentrations.

Deaths from air pollution. Referring to Slide 155, Chair Hayes asked how the review process determines acceptable risk in terms of $PM_{2.5}$-associated deaths. The panelist responded that the estimates of $PM_{2.5}$-related deaths are not meant to be read as absolute numbers but rather used as a basis for comparison between outcomes at different concentration levels to indicate the magnitude of public health impact. He further noted that risk assessments have not historically been the drivers of decisions regarding NAAQS. Council Member Solomon asked if lower concentrations had also been considered in the risk assessment. The panelist replied that they had, and that estimated deaths are reduced by 10-15% for each 1 µg/m^3 reduction.

PM thresholds? Council Member Borenstein asked if the panelist had seen any evidence of a PM threshold. The panelist replied that he had not. However, he explained that there may be thresholds for individuals that cannot be seen in population-level studies.

Targeting Particulate Matter: West Oakland Community Emissions Reduction Program

Phil Martien
Director, Assessment, Inventory, & Modeling, Bay Area Air Quality Management District
Project Lead, Technical Assessment of AB 617 West Oakland Community Action Plan

Main takeaways	**In response to California's AB 617 and in collaboration with communities, the Bay Area Air Quality Management District is implementing community-specific emissions reductions programs. The West Oakland plan demonstrates how hyperlocal modeling can be accomplished, but other agencies will also need to act in order to reach emissions reduction targets.**

Presentation Summary

Dr. Martien described the analysis conducted for the recently completed West Oakland Community Action Plan, the first in a series of community emissions reduction programs that the Air District is developing in response to California's AB 617 legislation.

Response to AB 617. California's Assembly Bill 617 mandates a statewide program to address long-standing air pollution concerns in disadvantaged communities. The Air District has committed to work collaboratively with disadvantaged communities experiencing disproportionately high levels of air pollution. The first year of implementation focused on Richmond and West Oakland; Richmond requires more measurements to be collected, but West Oakland had a large amount of data and was able to launch directly into planning an emissions reduction program. Beginning in year two, Air District efforts will expand to six more communities: Vallejo, the Pittsburg-Bay Point Area, Eastern San Francisco, the East Oakland-San Leandro Area, Tri-Valley, and San Jose.

Approach to West Oakland. West Oakland was chosen as the first implementation site both because its population experiences high socioeconomic burdens alongside low air quality and because West Oakland has a well-established and experienced community group, the West Oakland Environmental Indicators Project, that was able to guide the process in collaboration with the Air District. The study employed a hybrid modeling approach that first accounted for pollution originating outside the area in order to then zero in on local sources. In response to community requests, the study took a hyperlocal approach, modeling block-by-block exposures. Seven local impact zones were identified using data from specially equipped Google Street View vehicles. Sources modeled comprised the Port of Oakland, railyards and trains, vehicles on freeways and streets, truck-related businesses, and permitted stationary sources.

Results. Although the Port of Oakland was the primary contributor to diesel PM emissions, $PM_{2.5}$ showed a more distributed source allocation, with highway, street, port, and permitted sources all contributing significantly to $PM_{2.5}$ levels. However, approximately 34% of $PM_{2.5}$ came from sources not included in the model, such as construction, restaurants, and residential wood burning. For each zone, the proportional contributions of the different sources were calculated, with different allocations evident for each zone. For example, 60% of modeled $PM_{2.5}$ could be attributed to street traffic in Zone 3, whereas street traffic made up only 28% of $PM_{2.5}$ emissions in Zones 1 and 2. Disparate exposure levels were seen within the studied West Oakland zones: the cleanest blocks are experiencing on average 3 $\mu g/m^3$ lower PM concentrations than the most polluted blocks.

Action priorities. The West Oakland Community Action Plan established the goal of bringing all zones to average levels for the area by 2025 and to the level of today's cleanest residential West Oakland neighborhood by 2030. However, it is important to note that most of the pollution experienced in West Oakland comes from regional sources outside the West Oakland local area, and most of the local pollution sources are outside the Air District's jurisdiction. That said, priorities for decreasing exposures from local sources center on addressing sources with higher shares of modeled impact, which include heavy-duty trucks and harbor craft for diesel PM and road dust and passenger vehicles for $PM_{2.5}$.

Advisory Council Q&A with Panelist

West Oakland levels in comparison to other District areas. Council Member Rudolph asked how the "average" and "cleanest" levels in West Oakland that were set as targets compare to air pollution levels elsewhere in the Air District. The panelist responded that he does not have that information because other areas have not yet been assessed. However, he asserted that differences in pollution levels between West Oakland other parts of the Air District are likely to be driven by local impacts, so addressing disparities within the Air District can be accomplished by considering local pollution sources.

Electric vehicles and road dust. Council Member Rudolph pointed out that if road dust is a significant concern in terms of $PM_{2.5}$ exposure, then solutions like electric vehicles will not address that problem. The panelist agreed.

Capturing unrecorded emissions. Council Member Rudolph asked whether further analysis would be conducted to better understand the $PM_{2.5}$ contributors that were not accounted for in the study. The panelist indicated that expanding the list of modeled sources was among the "homework activities" for the Air District team developing further AB 617 action plans.

Translating findings into action. Council Member Long asked for clarification on how the information presented would be translated into concrete actions to improve air quality in West Oakland. The panelist acknowledged the challenge of the Air District's limited jurisdiction and asserted that the West Oakland community had a "realistic perspective" on what can be done. He described the West Oakland Community Action Plan (which calls for the implementation of strategies by the City of Oakland, Port of Oakland, Caltrans, CARB, PG&E, and others in addition to the Air District) as "a starting point."

PM Exposure and Risks: Discussion Summary

Because the event was running long and Advisory Council members had addressed their questions to the individual panelists, the discussion between the Advisory Council and the afternoon panel was brief.

Margin of safety. Vice Chair Kleinman asked for clarification on whether the risk assessment within the Draft PM Policy Assessment considered margin of safety for particulate matter. Dr. Jenkins responded that the risk assessment does not address margin of safety because the concept of safety rests solely within the judgement of the EPA Administrator.

Public Comment

Public comment was taken during two designated periods during the event. A list of the commenters during those periods follows the summary. Questions were also addressed to the lunchtime keynote speaker, former EPA Administrator Gina McCarthy.

Comment Summary

The general sentiment expressed by many commenters was, "We need action, not more discussion." Several people spoke about their personal experiences with toxic emissions in their neighborhoods. The disproportionate impact of air pollution on disadvantaged communities is a central point of focus.

Additional themes that emerged in public comment:

Physicians. A group of physicians expressed their position that they are not able to protect the health of their patients due to air pollution, particularly children with asthma. They emphasized the return on investment from improving air quality.

African American communities. Two attendees who addressed Gina McCarthy during her keynote speech focused on the challenges of African American communities in the Air District relative to cumulative impacts of air pollution problems and the need for education, training, and investment in environmental health.

Refineries. Several speakers expressed concerns about refineries in the Air District, both with respect to air pollution and the need to reduce or eliminate reliance on fossil fuels.

Mobile-source increases from stationary permits. A speaker from East Oakland highlighted air quality challenges from a local crematorium, not only from its direct emissions but also from diesel trucks making frequent deliveries.

Climate change. Concerns about climate change aspects of air pollution were emphasized in addition to the need to address immediate health issues.

Community representation. The suggestion was made to form a community advisory board for the Air District "with teeth," i.e., with the power to make and enact decisions.

List of commenters

PUBLIC COMMENT ON AGENDA MATTERS (ITEM 3)

Dr. Ashley McClure, California Climate Health Now
Sarah Schear, California Climate Health Now

PUBLIC COMMENT ON NON-AGENDA MATTERS (ITEM 7)

Katherine Funes, Rose Foundation for the Communities and the Environment
Jed Holtzman, 350 Bay Area
Jan Warren, Interfaith Climate Action Network of Contra Costa County
Dr. Amanda Millstein, California Climate Health Now
Dr. Cynthia Mahoney, California Climate Health Now
Sarah Schear, California Climate Health Now
Maureen Brennan, Rodeo citizen
Charles Davidson, Sunflower Alliance
Ken Szutu, Citizen’s Air Monitoring Network
Margie Lewis, Communities for a Better Environment
Steve Nadel, Sunflower Alliance

Advisory Council Deliberation

The symposium concluded with the Advisory Council's deliberation regarding the implications of the information presented. The Advisory Council arrived at the following Sense of the Advisory Council statement:

> **The current standard is not adequately health protective. Further reductions in particulate matter will realize additional health benefits. We ask the Air District staff to bring forward with urgency options within the legal authority of the Air District that would limit PM exposure, especially in high-risk communities.**

Council Member Borenstein reflected the sentiment of the Advisory Council in stating, "We need more science, and we should act."

Additionally, Advisory Council members expressed interest in further exploring the potential for:

Treating PM as a toxic. Council Member Solomon stated that the lack of evidence for a threshold for PM health effects argues for treatment of PM as a linear, non-threshold toxic in the same manner as other toxic air contaminants and carcinogens.

Monitoring ultrafine particles. Council Member Solomon indicated support for continuing monitoring of ultrafine particles in the Bay Area or increasing monitoring if the costs are not unreasonable. The Air District's Deputy Air Pollution Control Officer Greg Nudd proposed that the Air District present to the Advisory Council regarding the UFP monitoring that is already occurring in order to better inform the Advisory Council's recommendations.

Encouraging the State of California to adopt stricter PM standards. Acknowledging that the District does not have the authority to set ambient air standards, Vice Chair Kleinman suggested that those present in the room should encourage the State to adopt stricter PM standards.

Ensuring local permits are consistent with PM standards supported by the science. Vice Chair Kleinman stated that because local permits and emission requirements for stationary sources are the specific purview of the Air District, the Advisory Council should focus on advising the Board on how the Air District could make those determinations consistent with improved ambient air standards.

Disaggregating solutions with climate co-benefits, solutions unrelated to climate strategies, and emergencies. Council Member Long argued for separately approaching three different categories of strategies for addressing PM: 1) strategies that reduce particulate matter as a co-benefit of addressing climate change, such as making engines more efficient and decarbonizing electricity; 2) strategies regarding issues such as road dust that are independent of climate action (given that more efficient or electric cars still produce brake, tire, and road dust); and 3) emergencies including wildfires and explosions at permitted sites.

Bang for the buck. Council Member Long stressed the need to identify strategies with the greatest potential for impact and to track the outcomes of the strategies that are implemented.

Air District Implementation Plan. Vice Chair Kleinman stated the need for an Air District Implementation Plan in accordance with cleaner air standards. Chair Hayes expressed interest in the idea of an Air District Implementation Plan but stated that he was not yet ready to endorse the strategy and needed to gain a better understanding of what it would entail.

Next Steps

Three primary action items emerged from the first PM symposium:

1. **Air District delivery of presentations** to the Advisory Council on the Air District's current activities and capabilities to monitor ultrafine particles and to address PM exposures;
2. **Advisory Council discussion and deliberation** on these current and potential activities in light of the information presented at the October 28 symposium and summarized in this document; and
3. **Planning for a second symposium** for Spring 2020 to focus on community and other stakeholder input and engagement concerning PM exposures and health risks.

The Advisory Council will reconvene on **December 9, 2019**.

During that meeting, in response to the Advisory Council's requests, the Air District will present on its current activities to reduce PM exposures, including monitoring of ultrafine particles. It will also discuss additional "options within the legal authority of the Air District that would limit PM exposure, especially in high-risk communities," in accordance with the Sense of the Advisory Council, in order to inform the Advisory Council's advice to the Board.

The Advisory Council is expected to receive and comment on this symposium summary document during the December 9 meeting.

Planning for the Spring 2020 event continues with input from community representatives and other stakeholders.

Particulate Matter:
Spotlight on Health Protection

Call to Order
Pledge of Allegiance
Public Comment
Approval of Minutes

Stan Hayes

Particulate Matter:
Spotlight on Health Protection

Particulate Matter:
Spotlight on Health Protection

Welcome Remarks

Jack Broadbent

Particulate Matter:
Spotlight on Health Protection

Introduction

Jeff McKay

PM Symposium Series

28 Oct.

State of the science

9 Dec.

Advisory Council deliberation

Feb./Mar. 2020

Policy discussion and community participation

2nd Qtr. 2020

Joint Advisory Council/Board Meeting – District response to the PM Challenge

   

Health Effects

Jason Sacks, M.P.H.

- Senior Epidemiologist in the Center for Public Health & Environmental Assessment within U.S. EPA's Office of Research and Development
- Assessment lead for the Particulate Matter Integrated Science Assessment
- Key leadership roles in synthesizing the health effects evidence of air pollution for various National Ambient Air Quality Standards reviews
- International training on U.S. EPA's Environmental Benefits Mapping and Analysis Program – Community Edition
- M.P.H. from Johns Hopkins University in 2003

United States Environmental Protection Agency

Current State of Particulate Matter Science: Particulate Matter Integrated Science Assessment (PM ISA) (Working Draft Conclusions)

Particulate Matter: Spotlight on Health Protection

Bay Area Air Quality Management District

Jason Sacks

Center for Public Health and Environmental Assessment

Office of Research and Development

U.S. Environmental Protection Agency

October 28, 2019

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United States Environmental Protection Agency

Disclaimer

This presentation is based on information provided in the external review draft Integrated Science Assessment for Particulate Matter (PM ISA) as well as ongoing revisions to the PM ISA based on comments provided by the public and Clean Air Scientific Advisory Committee (CASAC). It has not been formally disseminated by EPA. It does not represent and should not be construed to represent any Agency determination or policy. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Outline

- PM NAAQS Milestones
- PM ISA
    - Weight-of-Evidence Evaluation
    - Scope
  - Ultrafine Particles (UFPs)
  - Causality Determinations: Health Effects
    - Likely to be Causal
    - $PM_{2.5}$ Sources and Components
    - Populations/Lifestages at Increased Risk
  - Next Steps

Overview of the Process for Reviewing the PM NAAQS

- IRP: Planned approach, schedule
- ISA: Assesses the available scientific information on public health and welfare effects; provides the science foundation for the review
- PA: Transparent analysis of the adequacy of the current standards and, as appropriate, potential alternatives

2014-2016

Planning
Call for Information and Public Workshop: Feb. 2015
Integrated Review Plan (IRP): Dec. 2016

2018-2020

Assessment
Integrated Science Assessment (ISA):
- External Review Draft: Oct. 2018
- Final ISA: Dec. 2019

Policy Assessment (PA): Sep. 2019

2020

Rulemaking
Agency decision making, interagency review and public comments process

Clean Air Scientific Advisory Committee (CASAC) review and public comment:
ISA: Dec. 2018
PA: Oct. 2019

Note: This NAAQS Review Process was originally outlined in Administrator Pruitt's May 9, 2018 "Back to Basics" Memo.

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Weight-of-Evidence Approach for Causality Determinations for Health and Welfare Effects

- Provides transparency through structured framework
- Developed and applied in ISAs for all criteria pollutants
- Emphasizes synthesis of evidence across scientific disciplines (e.g., controlled human exposure, epidemiologic, and toxicological studies)
- Five categories based on overall weight-of-evidence:
  - Causal relationship
  - Likely to be causal relationship
  - Suggestive of, but not sufficient to infer, a causal relationship
  - Inadequate to infer the presence or absence of a causal relationship
  - Not likely to be a causal relationship
- ISA Preamble describes this framework
  - Preamble is now stand-alone document (http://www.epa.gov/isa)
- CASAC extensively reviewed the Agency's causal framework in the process of reviewing ISAs from 2008 – 2015; <u>its use was supported in all ISAs</u>

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Scope

- **Scope:** The ISA is tasked with answering the question "Is there an independent effect of PM on health and welfare at relevant ambient concentrations?"
  - Health Effects
    - Studies will be considered if they include a composite measure of PM (e.g., $PM_{2.5}$ mass, $PM_{10\text{-}2.5}$ mass, ultrafine particle (UFP) number)
      - Studies of source-based exposures that contain PM (e.g., diesel exhaust, wood smoke, etc.) if they have a composite measure of PM and examine effects with and without particle trap to assess the particle effect
      - Studies of components of PM if they include a composite measure of PM to relate toxicity of component(s) to current indicator
    - Studies will be considered if PM exposures are relevant to ambient concentrations (< 2 mg/m^3; 1 to 2 orders of magnitude above ambient concentrations)

Ultrafine Particles (UFPs)

- Ultrafine particles are generally considered to be PM with a diameter less than or equal to 0.1 µm (100 nm)
- Uncertainties:
  - Highly variable concentration in space and over time due to physical and chemical processing in the atmosphere
    - UFP concentrations are highest in urban areas and during rush hour, and are highly episodic during winter
  - Lack of U.S. monitoring network and limited data on spatial and temporal UFP concentrations
  - UFP measured using multiple methods, varying in the size ranges examined - some capturing multiple size ranges below 100 nm, while others can include sizes above 100 nm
    - Contributed to difficulty in evaluating evidence within and across epidemiologic and experimental studies

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Draft PM ISA Health Effects: Causality Determinations

Table 1-5. Summary of causality determinations for health effect categories for the draft PM ISA.

HUMAN HEALTH EFFECTS					
		ISA	Current PM Draft ISA		
		Indicator	$PM_{2.5}$	$PM_{10-2.5}$	UFP
Health Outcome	Respiratory	Short-term exposure			
	Respiratory	Long-term exposure			
	Cardiovascular	Short-term exposure			
	Cardiovascular	Long-term exposure		*	
	Metabolic	Short-term exposure	*	*	*
	Metabolic	Long-term exposure	*	*	*
	Nervous System	Short-term exposure	*		*
	Nervous System	Long-term exposure	*	*	*
	Reproductive: Male/Female Reproduction and Fertility	Long-term exposure			
	Reproductive: Pregnancy and Birth Outcomes	Long-term exposure			
	Cancer	Long-term exposure	*	*	
	Mortality	Short-term exposure			
	Mortality	Long-term exposure		*	

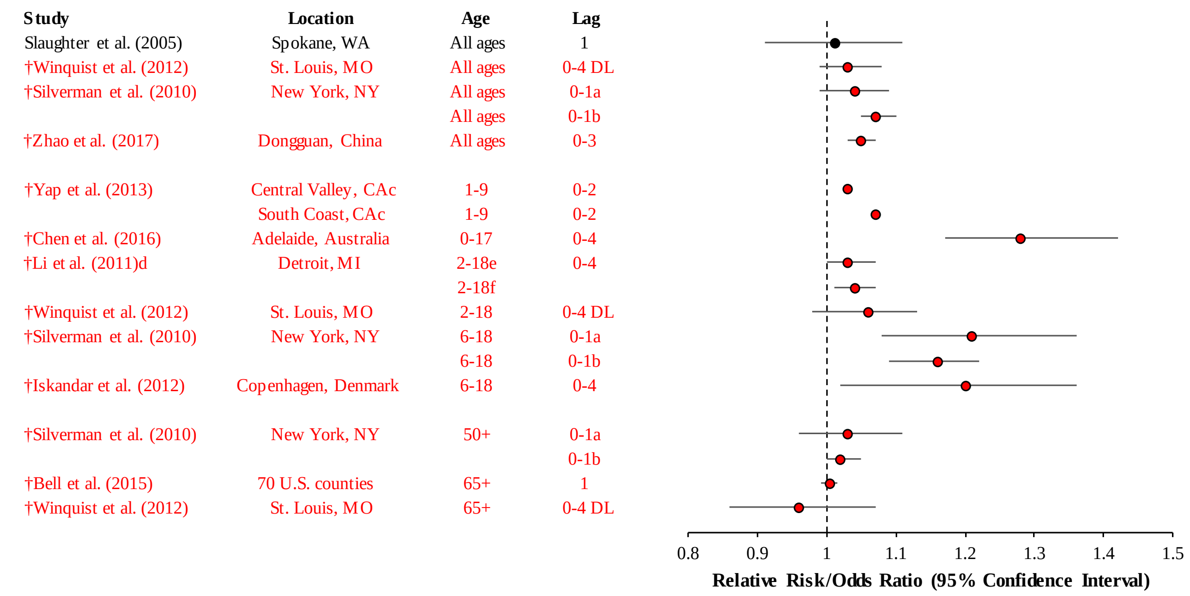
Causal | Likely causal | Suggestive | Inadequate

* = new determination or change in causality determination from 2009 PM ISA

Respiratory Effects

Recent evidence <u>supports</u> the conclusions of the 2009 PM ISA, and continues to support a <u>likely to be causal</u> relationship between <u>short-term</u> PM$_{2.5}$ exposure and respiratory effects

- <u>Epidemiologic evidence</u>:
  - o Consistent evidence for asthma exacerbation in children and COPD exacerbation in adults; respiratory mortality.
- <u>Experimental evidence</u>:
  - o Animal models of asthma and COPD demonstrate worsening of allergic airway disease and/or subclinical effects
- <u>Remaining Uncertainties</u>:
  - o Lack of coherence between epidemiologic and animal toxicological evidence because most effects demonstrated in healthy animals
  - o Minimal evidence from controlled human exposure studies for respiratory effects
  - o Limited assessment of potential copollutant confounding



<u>Figure 5-2</u>. Summary of associations between short-term PM$_{2.5}$ exposures and asthma hospital admissions for a 10 μg/m^3 increase in 24-hour average PM$_{2.5}$ concentrations.

Red = recent studies;
Black = U.S. study evaluated in the 2009 PM ISA

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Working Draft: Do Not Cite or Quote

Respiratory Effects (cont.)

Recent evidence supports the conclusions of the 2009 PM ISA, and continues to support a likely to be causal relationship between long-term $PM_{2.5}$ exposure and respiratory effects

- Epidemiologic evidence:
  - Consistent changes in lung function and lung function growth
  - Increased asthma incidence, asthma prevalence and wheeze in children
  - Acceleration of lung function decline in adults
  - Improvements in lung function growth with declining $PM_{2.5}$ concentrations
  - Consistent evidence for increased risk of respiratory mortality
- Experimental evidence:
  - Impaired lung development and development of allergic airway disease
  - Biological plausibility for decrements in lung function growth in children and asthma development
- Remaining Uncertainties:
  - Limited evidence from animal toxicological studies
  - Limited assessment of potential copollutant confounding

Nervous System Effects

- Long-term $PM_{2.5}$ Exposure **(Likely to be Causal – NEW conclusion)**
  - Epidemiologic evidence:
    - Consistent evidence for cognitive decline/impairment and decreased brain volume
    - Limited evidence for neurodegeneration (e.g., Alzheimer's disease and dementia)
  - Experimental evidence:
    - Consistent evidence for inflammation, oxidative stress, morphologic changes, and neurodegeneration in multiple brain regions of adult animals
    - Limited evidence for early indicators of Alzheimer's disease, impaired learning/memory, altered behavior in adult animals, and morphologic changes during development
  - Remaining Uncertainties:
    - Challenge conducting epidemiologic studies of neurodegeneration because often a genetic component
    - Epidemiologic studies of neurodevelopmental effects limited due to the small number of studies, and uncertainty regarding critical exposure windows
    - Limited assessment of potential copollutant confounding

Nervous System Effects

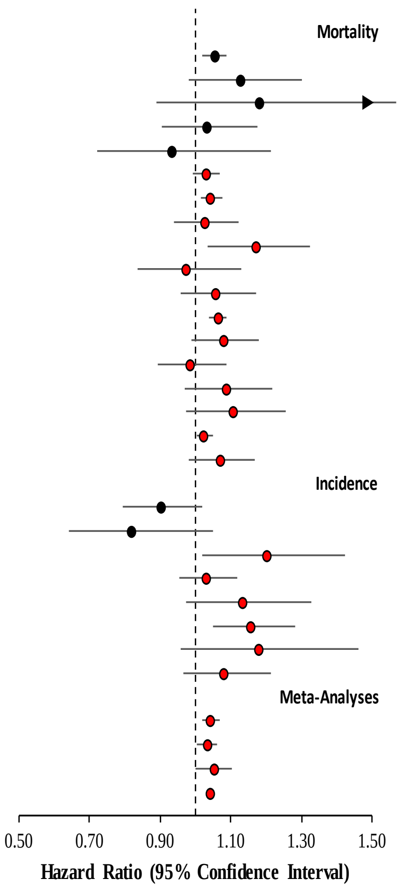
- Long-term UFP Exposure ****(Likely to be Causal – NEW conclusion)****
  - Epidemiologic evidence:
    - Limited evidence for effects on cognitive development in children
  - Experimental evidence:
    - Consistent evidence for inflammation, oxidative stress, and neurodegeneration in adult animals
    - Limited evidence of Alzheimer's disease pathology in a susceptible animal model
    - Strong evidence of developmental effects, mainly from one laboratory, for inflammation, morphologic changes including persistent ventriculomegaly, and behavioral effects following pre/postnatal exposure
  - Remaining Uncertainties:
    - Relative lack of epidemiologic studies
    - Inconsistency in size range of UFPs examined across disciplines
    - Spatial and temporal variability in UFP concentrations
    - Relative lack of UFP monitoring data
    - Long-term exposure to UFPs

Cancer

Long-term $PM_{2.5}$ Exposure (Likely to be Causal – NEW conclusion)

- Decades of research on whole PM exposures:
  - o Genotoxicity
  - o Epigenetic effects
  - o Carcinogenic potential
  - o Characteristics of carcinogens
- Experimental and epidemiologic studies examining $PM_{2.5}$ support:
  - o Genotoxicity
  - o Epigenetic effects
  - o Carcinogenic potential
  - o Characteristics of carcinogens
- Epidemiologic evidence:
  - o Lung cancer incidence and mortality
- Remaining Uncertainties:
  - o Inconsistency in specific cancer-related biomarkers across disciplines
  - o Limited assessment of copollutant confounding

Study	Cohort	Location	Follow-up Years	Qualifier
Krewski et al. (2009)	ACS (Re-analysis)	U.S.	1982-2000	
Laden et al. (2006)	HSC	6 U.S. cities	1974-1998	
McDonnell et al. (2000)	AHSMOG	California	1973-1977	Men
Brunekreef et al. (2009)a	NLCS - Air	Netherlands	1987-1996	Full Cohort
Brunekreef et al. (2009)a	NLCS - Air	Netherlands	1987-1996	Case Cohort
†Thurston et al. (2013)	ACS-CPS II	U.S.	1982-2004	
†Turner et al. (2016)	ACS-CPS II	U.S.	1982-2004	
†Hart et al. (2011)	TrIPS	U.S.	1985-2000	Men
†Lepeule et al. (2012)	HSC	6 U.S. cities	1974-2009	
†Lipsett et al. (2011)	CTS	California	2000-2005	Women
†Jerrett et al. (2013)	ACS-CPS II	California	1982-2000	
†Crouse et al. (2015)	CanCHEC	Canada	1991-2006	
†Pinault et al. (2016)	CCHS	Canada	2000-2011	
†Villeneuve et al. (2015)	CNBSS	Canada	1980-2005	Women
†Weichenthal et al. (2016)	CanCHEC	Ontario	1991-2009	
†Carey et al. (2013)	National English	United Kingdom	2003-2007	
†Cesaroni et al. (2013)	RoLS	Rome, Italy	2001-2010	
†Wong et al. (2016)	---	Hong Kong	1998-2011	
Brunekreef et al. (2009)b	NLCS - Air	Netherlands	1987-1996	Full Cohort
Brunekreef et al. (2009)b	NLCS - Air	Netherlands	1987-1996	Case Cohort
†Gharibvand et al. (2016)	AHSMOG-2	U.S.	2002-2011	
†Puett et al. (2014)	NHS	U.S.	1994-2010	Women
†Hystad et al. (2013)	NECSS	Canada	1994-1997	
†Tomczak et al. (2016)	CNBSS	Canada	1980-2004	Women
†Raaschou-Nielsen et al. (2013)	ESCAPE	Europe	1990s	
†Hart et al. (2015)	NCLS	Netherlands	1986-2003	
†Hamra et al. (2014)c	---	---	---	14 studies
†Yang et al. (2015)c	---	---	---	10 studies
†Chen et al. (2015)c	---	---	---	6 studies
†Cui et al. (2015)d	---	---	---	12 studies



Note: Red = recent studies; Black = studies evaluated in the 2009 PM ISA

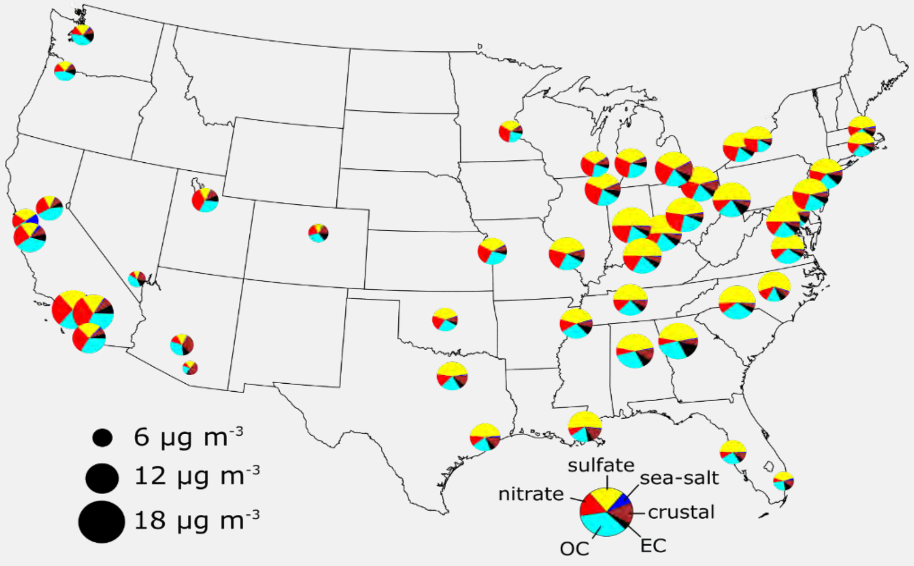
Figure 10-3. Summary of associations reported in previous and recent cohort studies that examined long-term $PM_{2.5}$ exposure and lung cancer mortality and incidence.

PM Components and Sources

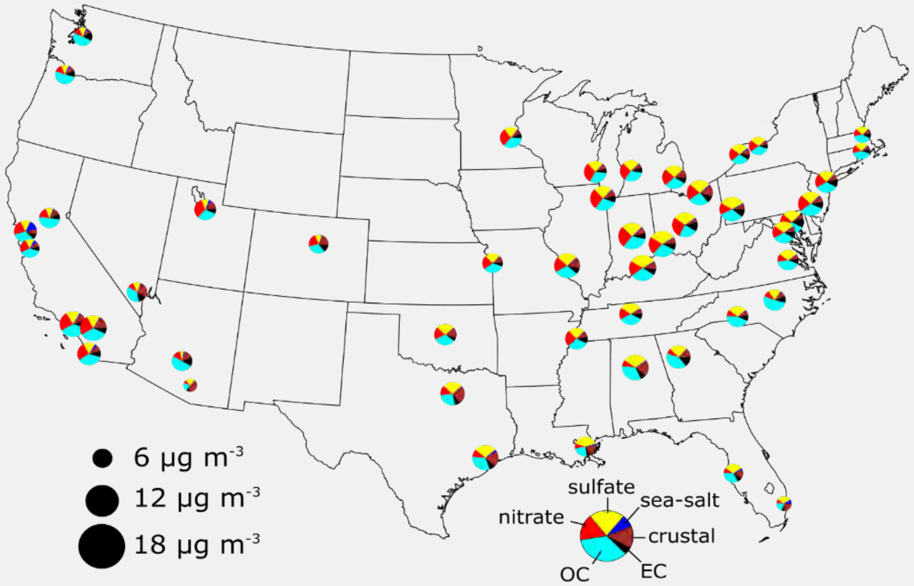
- <u>Conclusion</u>:
  - o Many $PM_{2.5}$ components and sources are associated with many health effects, and the evidence <u>does not indicate</u> that any one source or component is more strongly related with health effects than $PM_{2.5}$ mass
    - Evaluation of individual components, based largely on evidence from epidemiologic studies
    - Evaluation of sources limited to a smaller subset of studies
      - Across studies, consistent evidence for effects with various combustion-related sources (e.g., industrial activities, traffic, wildfires, biomass burning, etc.)

EPA United States Environmental Protection Agency

National Trend in $PM_{2.5}$ Component Concentrations



2003 - 2005



2013 - 2015

- 2003 - 2005: As % of total mass, sulfate higher in East; OC in West
- 2013 – 2015: Reduction in sulfate contribution in East; contributions similar to 2003 – 2005 in West
- Overall: Organic carbon has replaced sulfate as the most abundant component of $PM_{2.5}$ in many locations, specifically in the eastern U.S.

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Example: $PM_{2.5}$ Components and Cardiovascular Effects

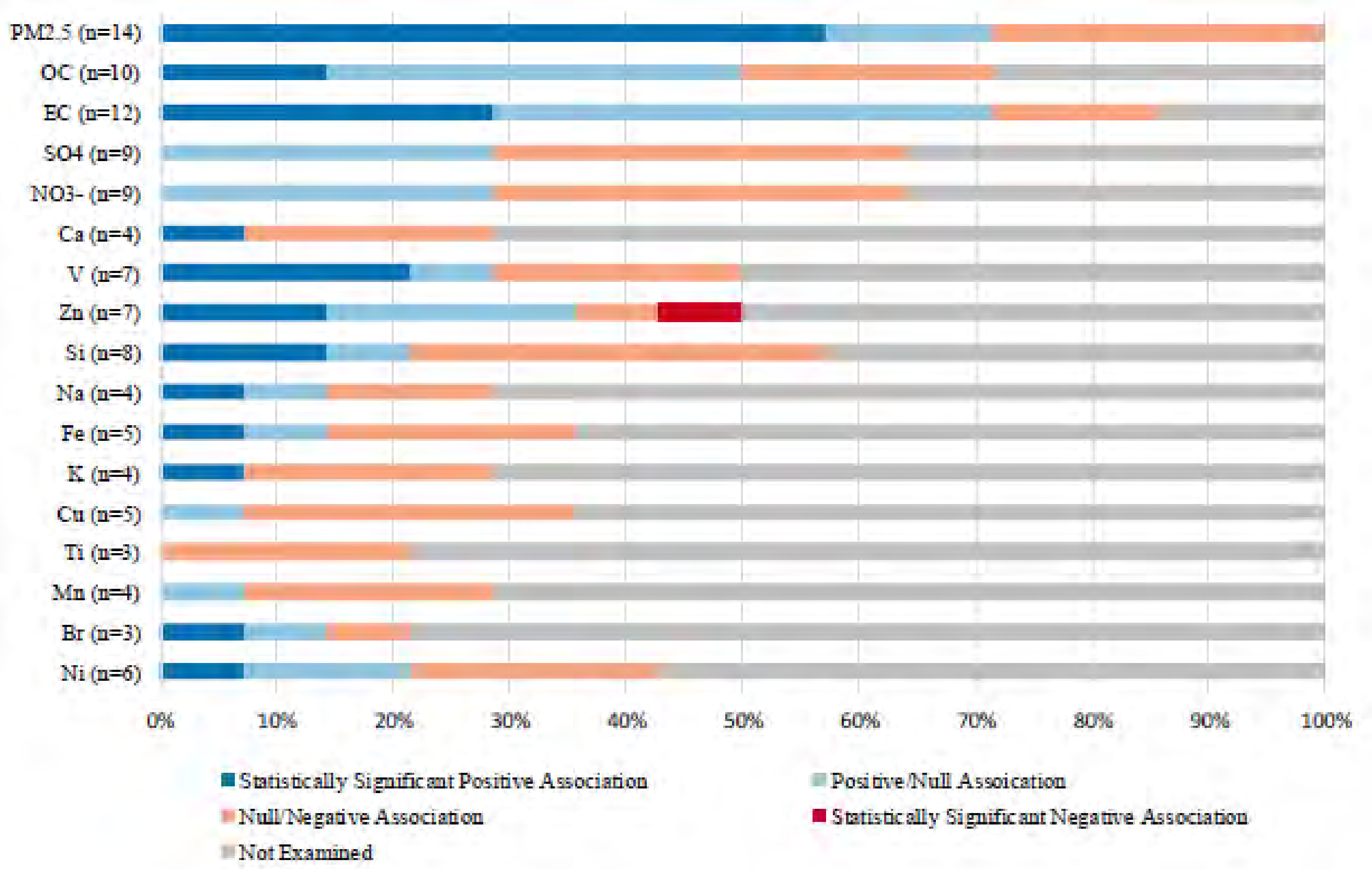

Figure 6-15. Distribution of associations for hospital admissions and emergency department visits for cardiovascular-related effects and short-term $PM_{2.5}$ and $PM_{2.5}$ components exposure.

Populations Potentially at Increased Risk of a PM-related Health Effect

- The NAAQS are intended to protect both the population as a whole and those potentially at increased risk for health effects in response to exposure to criteria air pollutants
  - *Are there specific populations and lifestages at increased risk of a PM-related health effect, <u>compared to a reference population</u>?*
- The ISA identified and evaluated evidence for factors that may increase the risk of $PM_{2.5}$-related health effects in a population or lifestage, classifying the evidence into four categories:
  - Adequate evidence; suggestive evidence; inadequate evidence; evidence of no effect
- Conclusions:
  - <u>Adequate</u>: children and nonwhite populations
  - <u>Suggestive</u>: pre-existing cardiovascular and respiratory disease, overweight/obese, genetic variants glutathione transferase pathways, low SES
  - <u>Inadequate</u>: pre-existing diabetes, older adults, residential location, sex, diet, and physical activity

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United States Environmental Protection Agency

Supplemental Materials

United States Environmental Protection Agency

Framework for Causality Determinations in the ISA

	Health Effects	Ecological and Other Welfare Effects
Causal relationship	Evidence is sufficient to conclude that there is a causal relationship with relevant pollutant exposures (e.g., doses or exposures generally within one to two orders of magnitude of recent concentrations). That is, the pollutant has been shown to result in health effects in studies in which chance, confounding, and other biases could be ruled out with reasonable confidence. For example: (1) controlled human exposure studies that demonstrate consistent effects, or (2) observational studies that cannot be explained by plausible alternatives or that are supported by other lines of evidence (e.g., animal studies or mode of action information). Generally, the determination is based on multiple high-quality studies conducted by multiple research groups.	Evidence is sufficient to conclude that there is a causal relationship with relevant pollutant exposures. That is, the pollutant has been shown to result in effects in studies in which chance, confounding, and other biases could be ruled out with reasonable confidence. Controlled exposure studies (laboratory or small- to medium-scale field studies) provide the strongest evidence for causality, but the scope of inference may be limited. Generally, the determination is based on multiple studies conducted by multiple research groups, and evidence that is considered sufficient to infer a causal relationship is usually obtained from the joint consideration of many lines of evidence that reinforce each other.
Likely to be a causal relationship	Evidence is sufficient to conclude that a causal relationship is likely to exist with relevant pollutant exposures. That is, the pollutant has been shown to result in health effects in studies where results are not explained by chance, confounding, and other biases, but uncertainties remain in the evidence overall. For example: (1) observational studies show an association, but copollutant exposures are difficult to address and/or other lines of evidence (controlled human exposure, animal, or mode of action information) are limited or inconsistent, or (2) animal toxicological evidence from multiple studies from different laboratories demonstrate effects, but limited or no human data are available. Generally, the determination is based on multiple high-quality studies.	Evidence is sufficient to conclude that there is a likely causal association with relevant pollutant exposures. That is, an association has been observed between the pollutant and the outcome in studies in which chance, confounding, and other biases are minimized but uncertainties remain. For example, field studies show a relationship, but suspected interacting factors cannot be controlled, and other lines of evidence are limited or inconsistent. Generally, the determination is based on multiple studies by multiple research groups.
Suggestive of, but not sufficient to infer, a causal relationship	Evidence is suggestive of a causal relationship with relevant pollutant exposures but is limited, and chance, confounding, and other biases cannot be ruled out. For example: (1) when the body of evidence is relatively small, at least one high-quality epidemiologic study shows an association with a given health outcome and/or at least one high-quality toxicological study shows effects relevant to humans in animal species, or (2) when the body of evidence is relatively large, evidence from studies of varying quality is generally supportive but not entirely consistent, and there may be coherence across lines of evidence (e.g., animal studies or mode of action information) to support the determination.	Evidence is suggestive of a causal relationship with relevant pollutant exposures, but chance, confounding, and other biases cannot be ruled out. For example, at least one high-quality study shows an effect, but the results of other studies are inconsistent.
Inadequate to infer a causal relationship	Evidence is inadequate to determine that a causal relationship exists with relevant pollutant exposures. The available studies are of insufficient quantity, quality, consistency, or statistical power to permit a conclusion regarding the presence or absence of an effect.	Evidence is inadequate to determine that a causal relationship exists with relevant pollutant exposures. The available studies are of insufficient quality, consistency, or statistical power to permit a conclusion regarding the presence or absence of an effect.
Not likely to be a causal relationship	Evidence indicates there is no causal relationship with relevant pollutant exposures. Several adequate studies, covering the full range of levels of exposure that human beings are known to encounter and considering at-risk populations and lifestages, are mutually consistent in not showing an effect at any level of exposure.	Evidence indicates there is no causal relationship with relevant pollutant exposures. Several adequate studies examining relationships with relevant exposures are consistent in failing to show an effect at any level of exposure.

Multiple, high-quality studies
Rule out chance, confounding, and other biases with reasonable confidence

Multiple, high-quality studies
Important uncertainties remain

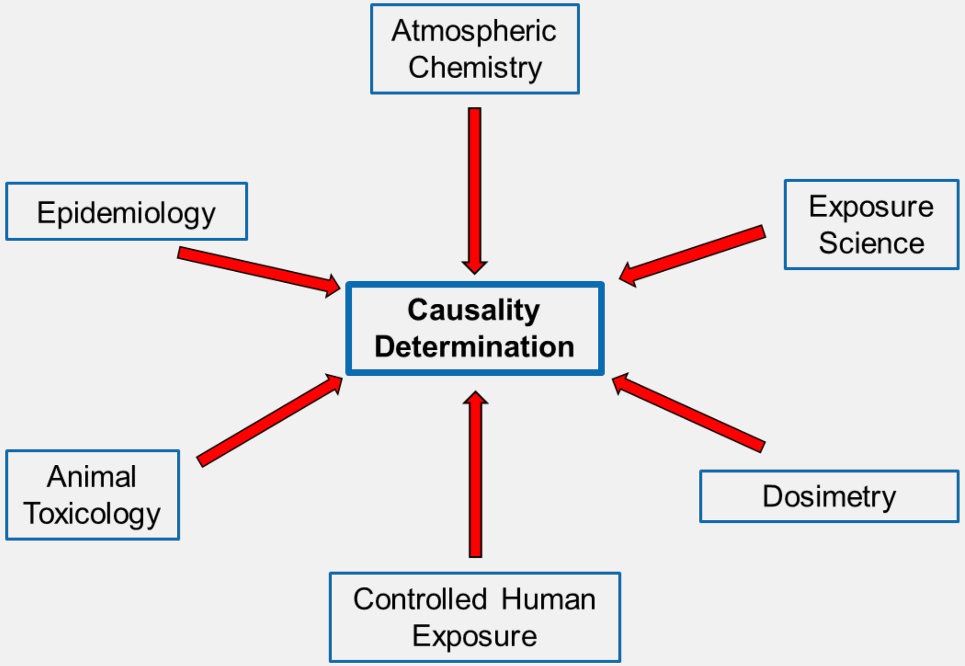
Evidence is suggestive but limited

Evidence is of insufficient quantity, quality, consistency, or statistical power

Multiple studies show no effect across exposure concentrations

Evaluation of the Scientific Evidence

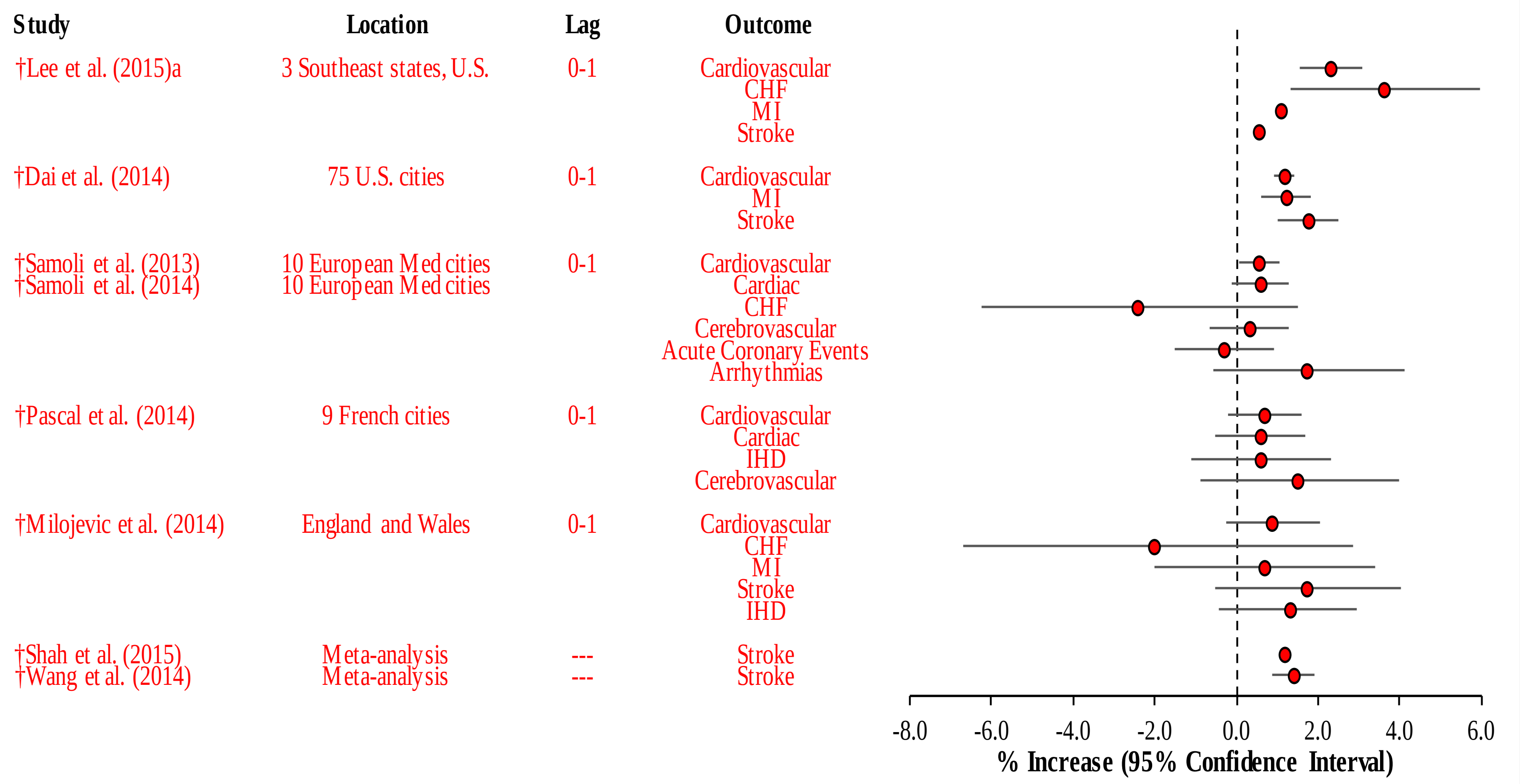
- Organize relevant literature for broad outcome categories
- Evaluate studies, characterize results, extract relevant data
- Integrate evidence across disciplines for outcome categories
- Develop causality determinations using established framework
- Evaluate evidence for populations potentially at increased risk
- Consideration of evidence spans many scientific disciplines from source to effect:
    - Atmospheric chemistry
    - Exposure
    - Controlled human exposure studies
    - Epidemiologic studies
    - Animal toxicologic studies



C60

Cardiovascular Effects

A large body of recent evidence <u>supports and extends</u> the conclusions of the 2009 PM ISA that there is a <u>causal relationship</u> between short- and long-term $PM_{2.5}$ exposure and cardiovascular effects



Note: Red = recent studies; Black = studies evaluated in the 2009 PM ISA

Figure 6-7. Percent increase in cause-specific cardiovascular mortality outcomes for a 10 μg/m³ increase in 24-hour average $PM_{2.5}$ concentrations observed in multicity studies and meta-analyses.

C61

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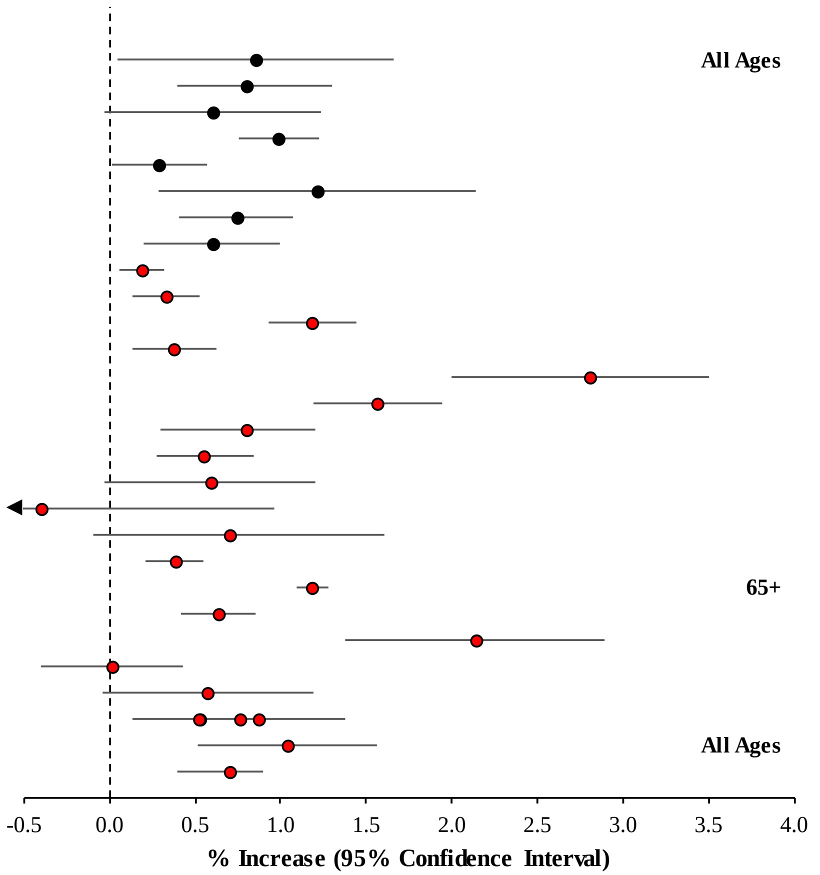
Mortality – Short-term $PM_{2.5}$ Exposure

Recent evidence <u>supports and extends</u> the conclusions of the 2009 PM ISA that there is a <u>causal relationship</u> between short-term $PM_{2.5}$ exposure and mortality

Study	Location	Lag
Burnett and Goldberg (2003)	8 Canadian cities	1
Klemm and Mason (2003)	6 U.S. cities	0-1
Burnett et al. (2004)	12 Canadian cities	1
Zanobetti and Schwartz (2009)	112 U.S. cities	0-1
Dominici et al. (2007)	96 U.S. cities (NMMAPS)	1
Franklin et al. (2007)	27 U.S. cities	1
Franklin et al. (2008)	25 U.S. cities	0-1
Ostro et al. (2006)	9 CA counties	0-1
†Lippmann et al. (2013)	148 U.S. cities	0
†Baxter et al. (2017)	77 U.S. cities	0-1
†Dai et al. (2014)	75 U.S. cities	0-1
†Krall et al. (2013)	72 U.S. cities	1
†Kloog et al. (2013)	New England, U.S.	0-1
†Lee et al. (2015)a	3 Southeast states, U.S.	0-1
†Janssen et al. (2013)	Netherlands	0
†Samoli et al (2013)	10 European Med cities	0-1
†Stafoggia et al. (2017)	8 European cities	1
†Lanzinger et al. (2016)b	5 Central European cities (UFIREG)	0-1
†Pascal et al. (2014)	9 French cities	0-1
†Lee et al. (2015)	11 East Asian cities	0-1
†Di et al. (2017)c	U.S. - Nation	0-1
†Zanobetti et al. (2014)c	121 U.S. cities	0-1
†Shi et al. (2015)c	New England, U.S.	0-1
†Young et al. (2017)	8 CA air basins	0-1d
	8 CA air basins	0-3e
†Ueda et al. (2009)f	20 Japanese areas	1
†Atkinson et al (2014)	Meta-analysis	---g
†Adar et al. (2014)	Meta-analysis	---h



Note: Red = recent multi-city studies; Black = multi-city studies evaluated in the 2009 PM ISA

Figure 11-1. Summary of associations between short-term $PM_{2.5}$ exposure and total (nonaccidental) mortality in multicity studies for a 10 $\mu g/m^3$ increase in 24-hour average concentrations.

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Mortality – Long-term $PM_{2.5}$ Exposure

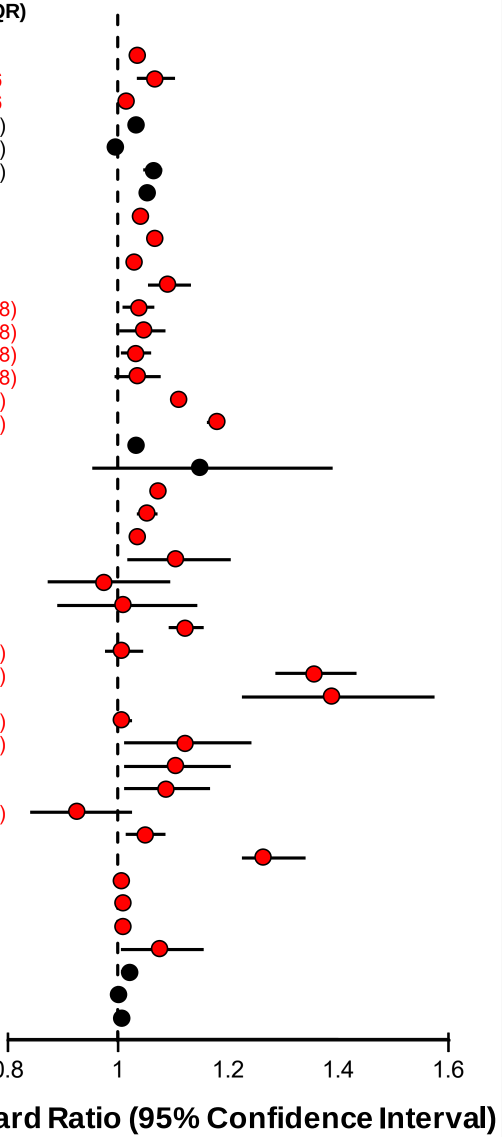
Recent evidence supports and extends the conclusions of the 2009 PM ISA that there is a causal relationship between long-term $PM_{2.5}$ exposure and mortality

Figure 11-18. Associations between long-term $PM_{2.5}$ and total (nonaccidental) mortality in recent North American cohorts.

Note: Associations are presented per 5 µg/m^3 increase in pollutant concentration.

Red = recent studies; Black = studies evaluated in the 2009 PM ISA

Reference	Cohort	Notes	Years	Mean (IQR)
†Pope et al. 2014	ACS		1982-2004	12.6
†Lepeule et al. 2012	Harvard Six Cities		1974-2009	11.4-23.6
†Thurston et al. 2015	NIH-AARP		2000-2009	10.2-13.6
Zeger et al. 2008	MCAPS	Eastern	2000-2005	14.0 (3.0)
Zeger et al. 2008	MCAPS	Western	2000-2005	13.1 (8.1)
Zeger et al. 2008	MCAPS	Central	2000-2005	10.7 (2.4)
Eftim et al. 2008	ACS-Medicare		2000-2002	13.6
†Di et al. 2017	Medicare		2000-2012	11.5
†Di et al. 2017	Medicare	exp<12	2000-2012	11.5
†Di et al. 2017	Medicare	nearest monitor	2000-2012	11.5
†Kioumourtzoglou et al. 2016	Medicare		2000-2010	12
†Shi et al. 2015	Medicare	mutual adj	2003-2008	8.12 (3.78)
†Shi et al. 2015	Medicare	exp <10, mutual adj	2003-2008	8.12 (3.78)
†Shi et al. 2015	Medicare	no mutual adj	2003-2008	8.12 (3.78)
†Shi et al. 2015	Medicare	exp <10, no mutual adj	2003-2008	8.12 (3.78)
†Wang et al. 2017	Medicare		2000-2013	10.7 (3.8)
†Wang et al. 2017	Medicare	exp<12	2000-2013	10.7 (3.8)
Lipfert et al. 2006	Veterans Cohort		1997-2001	14.34
Goss et al. 2004	U.S. Cystic Fibrosis		1999-2000	13.7
†Crouse et al. 2012	CanCHEC	Satellite data	1991-2001	8.9
†Crouse et al. 2012	CanCHEC	Monitor data	1991-2001	11.2
†Crouse et al. 2015	CanCHEC		1991-2006	8.9
†Chen et al. 2016	EFFECT		1999-2011	10.7
†Weichenthal et al. 2014	Ag Health		1993-2009	8.84
†Weichenthal et al. 2014	Ag Health	more precise exp	1993-2009	8.84
†Pinault et al. 2016	CCHS		1998-2011	6.3
†Lipsett et al. 2011	CA Teachers		2000-2005	15.6 (8.0)
†Ostro et al. 2010	CA Teachers	within 30 km	2002-2007	17.5 (6.1)
†Ostro et al. 2010	CA Teachers	within 8 km	2002-2007	17 (6.1)
†Ostro et al. 2015	CA Teachers		2001-2007	17.9 (9.6)
†Puett et al. 2009	Nurses Health		1992-2002	13.9 (3.6)
†Hart et al. 2015	Nurses Health	nearest monitor	2000-2006	12.7
†Hart et al. 2015	Nurses Health	spatio-temp. model	2000-2006	12
†Puett et al. 2011	Health Prof	full model	1989-2003	17.8 (4.3)
†Hart et al. 2011	TrIPS		1985-2000	14.1 (4)
†Kloog et al. 2013	MA cohort	CVD+Resp	2000-2008	9.9 (1.6)
†Garcia et al. 2015	CA cohort	Kriging	2006	13.06
†Garcia et al. 2015	CA cohort	IDW	2006	12.94
†Garcia et al. 2015	CA cohort	closest monitor	2006	12.68
†Wang et al. 2016	NJ Cohort		2004-2009	11.3
Enstrom 2005	CA Cancer Prev		1973-1982	23.4
Enstrom 2005	CA Cancer Prev		1983-2002	23.4
Enstrom 2005	CA Cancer Prev		1973-2002	23.4



Working Draft: Do Not Cite or Quote

United States Environmental Protection Agency

Policy-Relevant Considerations (Chapter 1)

- **Copollutant Confounding**: Across recent studies examining various health effects and both short- and long-term $PM_{2.5}$ exposures, associations remain relatively unchanged in copollutant models

- **Concentration-Response (C-R) Relationship**: Across studies evidence continues to support a linear, no-threshold C-R relationship

- **PM Components and Sources**: Many $PM_{2.5}$ components and sources are associated with many health effects, and the evidence does not indicate that any one source or component is more strongly related with health effects than $PM_{2.5}$ mass

$PM_{2.5}$ Components and Respiratory Effects

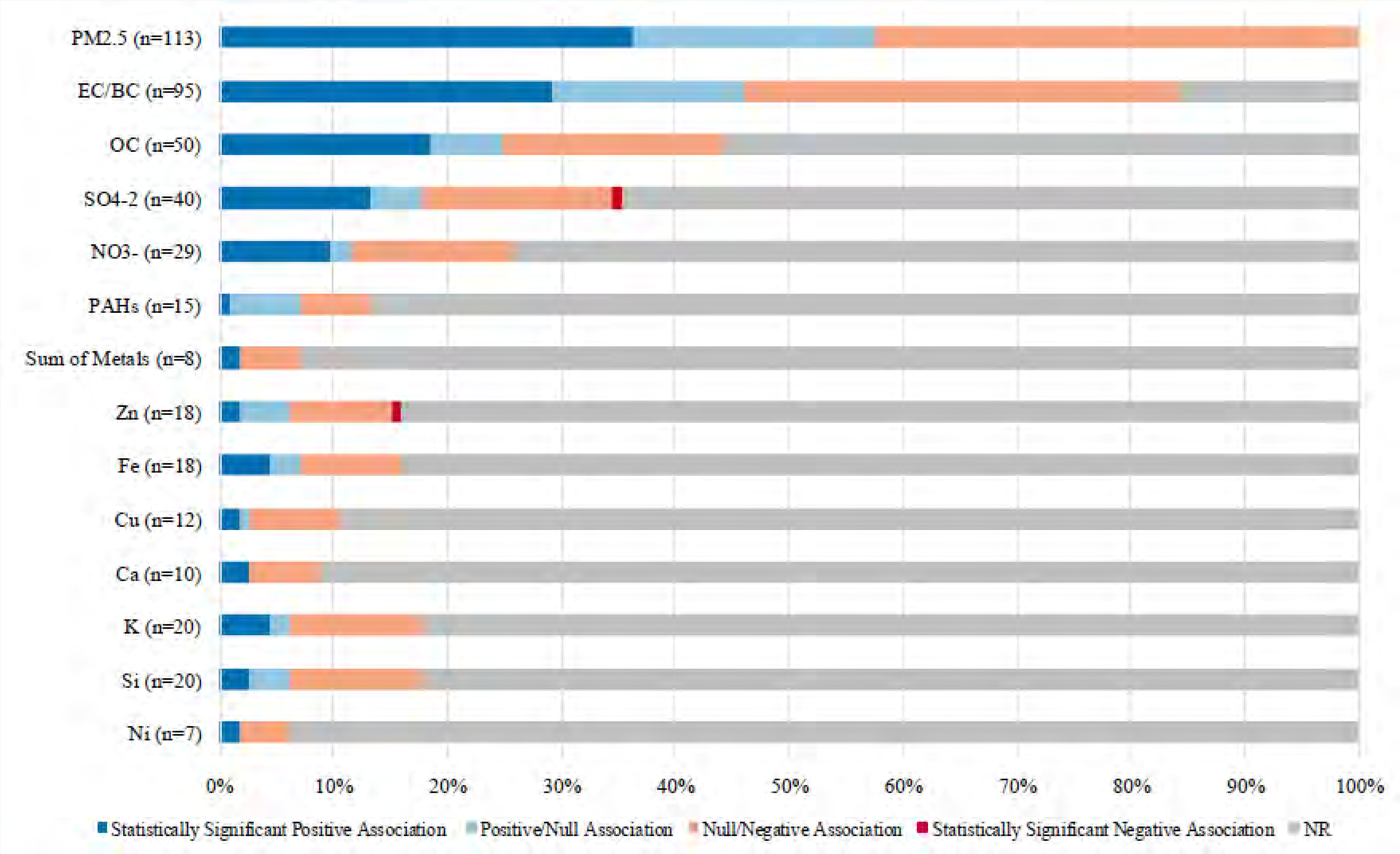


Figure 5-25. Distribution of associations for all respiratory effects and short-term $PM_{2.5}$ mass and $PM_{2.5}$ components exposure.

$PM_{2.5}$ Components and Mortality

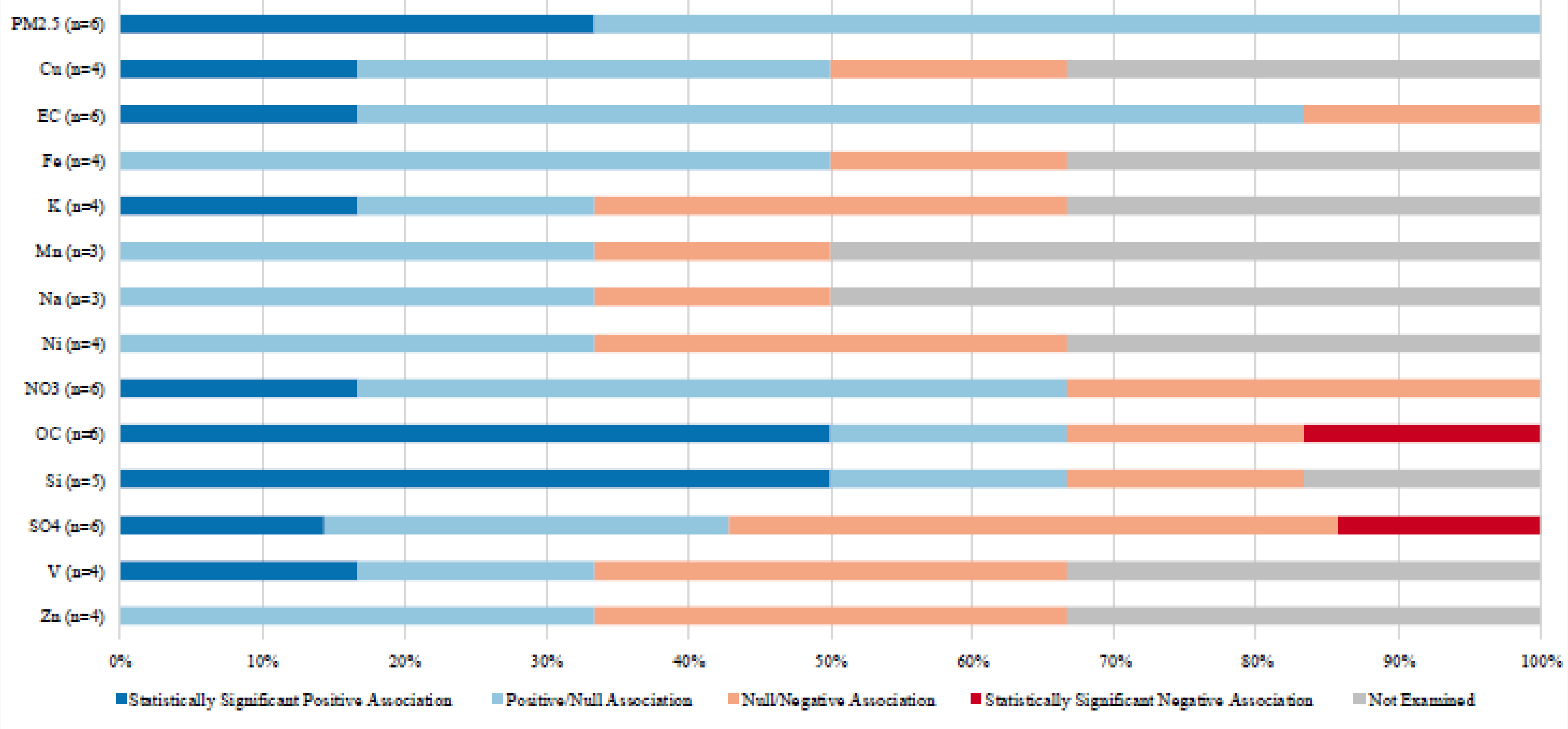


Figure 6-15. Distribution of total (nonaccidental) mortality associations for short-term $PM_{2.5}$ and $PM_{2.5}$ components exposure.

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Scope (cont.)

- Welfare Effects
  - Focus is on non-ecological welfare effects
    - Visibility Impairment
    - Climate Effects
    - Materials Effects
  - Ecological effects resulting from the deposition of PM and PM components are being considered as part of the review of the secondary (welfare-based) NAAQS for oxides of nitrogen, oxides of sulfur and PM

United States Environmental Protection Agency

Draft PM ISA
Welfare Effects: Causality Determinations

NONECOLOGICAL WELFARE EFFECTS		
	ISA	Current PM Draft ISA
		PM
Welfare Effect	Visibility	
	Climate	
	Materials	

Causal | Likely causal | Suggestive | Inadequate

* = new determination or change in causality determination from 2009 PM ISA

Welfare Effects (Chapter 13)

Recent evidence <u>supports and extends</u> the conclusions of the 2009 PM ISA that there is a <u>causal relationship</u> between PM and welfare effects

- Visibility Impairment **(Causal)**
  - Long-term visibility improvements throughout the U.S as PM concentrations have decreased
  - Regional and seasonal patterns in atmospheric visibility parallel PM concentration patterns
  - More evidence supporting the relationship between visibility and PM composition
- Climate Effects **(Causal)**
  - New evidence provides greater specificity about radiative forcing
  - Increased understanding of additional climate impacts driven by PM radiative effects
  - Improved characterization of key sources of uncertainty particularly with response to PM-cloud interactions
- Materials Effects **(Causal)**
  - New information for glass and metals including modeling of glass soiling
  - Progress in the development of quantitative dose-response relationships and damage functions for materials in addition to stone, including glass and metals
  - Quantitative research on PM impacts on energy yield from photovoltaic systems

C69

EPA United States Environmental Protection Agency

At-Risk Framework Description

Classification	Health Effects
Adequate evidence	There is substantial, consistent evidence within a discipline to conclude that a factor results in a population or lifestage being at increased risk of air pollutant-related health effect(s) relative to some reference population or lifestage. Where applicable, this evidence includes coherence across disciplines. Evidence includes multiple high-quality studies.
Suggestive evidence	The collective evidence suggests that a factor results in a population or lifestage being at increased risk of air pollutant-related health effect(s) relative to some reference population or lifestage, but the evidence is limited due to some inconsistency within a discipline or, where applicable, a lack of coherence across disciplines.
Inadequate evidence	The collective evidence is inadequate to determine whether a factor results in a population or lifestage being at increased risk of air pollutant-related health effect(s) relative to some reference population or lifestage. The available studies are of insufficient quantity, quality, consistency, and/or statistical power to permit a conclusion to be drawn.
Evidence of no effect	There is substantial, consistent evidence within a discipline to conclude that a factor does not result in a population or lifestage being at increased risk of air pollutant-related health effect(s) relative to some reference population or lifestage. Where applicable, the evidence includes coherence across disciplines. Evidence includes multiple high-quality studies.

Excerpt from Preamble to ISAs

Particulate Matter:
Spotlight on Health Protection

Michael Kleinman, Ph.D.

- UC Irvine Professor of Environmental Toxicology
- Co-Director of the Air Pollution Health Effects Laboratory in the Department of Community and Environmental Medicine
- Adjunct Professor in College of Medicine
- Serves on the Air District Advisory Council
- Ph.D. in Environmental Health Sciences from New York University

COMPLEX MIXTURE THAT AFFECTS HEALTH

Michael T. Kleinman

With the help of David Herman, Rebecca Johnson, Lisa Wingen and a lot of other people

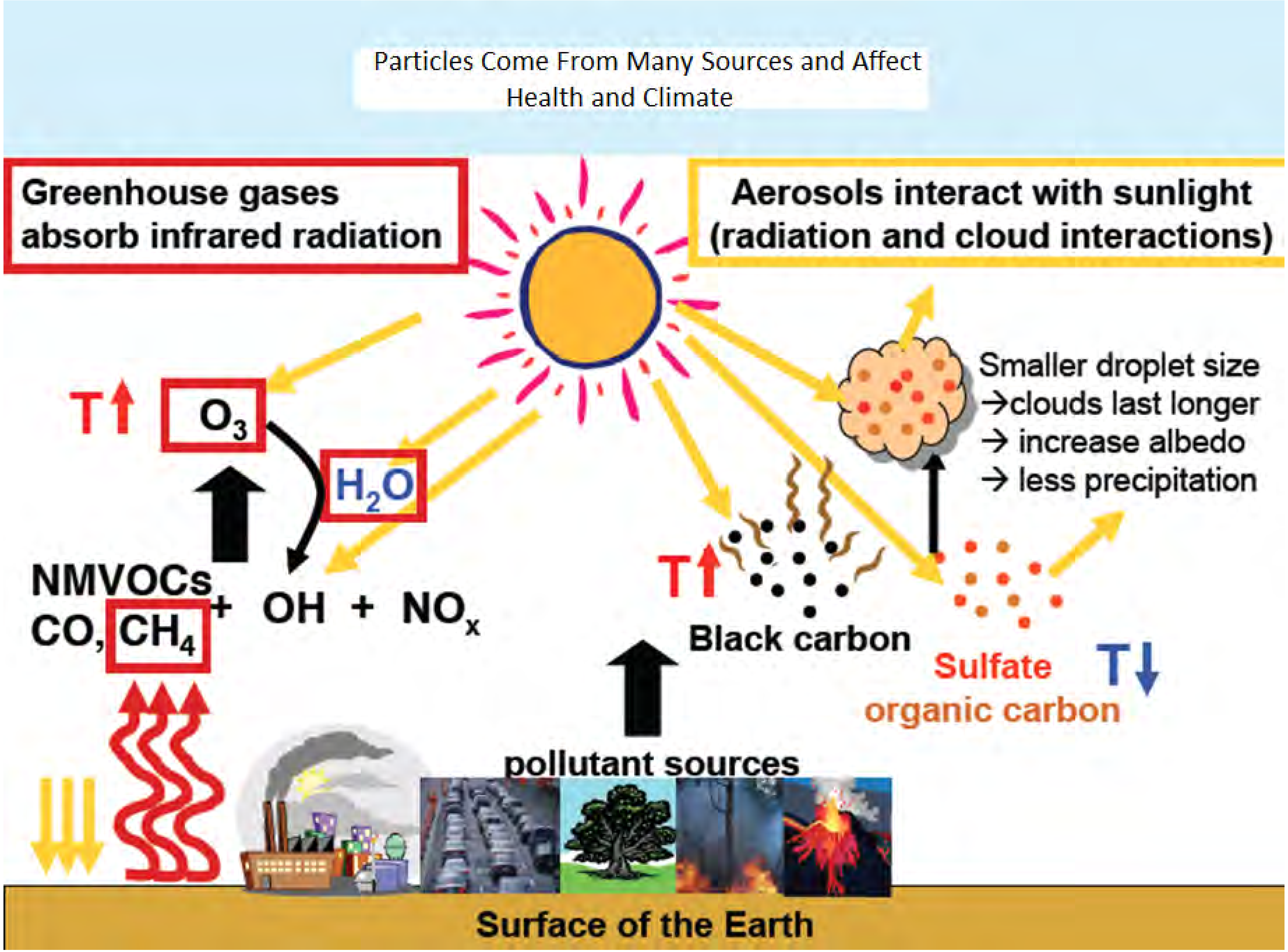
University of California, Irvine

Overall Goal of this Presentation is to Address These Questions

- Why are some species of PM more dangerous than others?
- How does PM affect health?
- Do ultrafine particles (UFPs) have a special role?

What are the health-relevant components of urban air?

- Emissions from power plants, motor vehicles, dust.
- Pollutants gases:
  - Ozone and NO_2 are major problems in California.
  - SO_2 and organic vapors are also important.
- Particles or Particulate Matter (PM):
  - Particles are associated with increased heart-related deaths during air pollution episodes.
  - Toxicology studies show that PM2.5 accelerates the development of atherosclerosis.
  - The strongest associations with human heart-related illness and death are with PM.
  - PM composition includes toxic organic and inorganic chemicals
- Combustion sources generate fine and ultrafine PM often coated with toxic substances.
  - Polycyclic Aromatic Hydrocarbons (PAHs)
  - Carbonyls (acrolein, formaldehyde)
  - Quinones



Particles Come From Many Sources and Affect Health and Climate
Greenhouse gases absorb infrared radiation
Aerosols interact with sunlight (radiation and cloud interactions)
T↑
O_3
H_2O
NMVOCs
CO, CH_4 + OH + NO_x
Smaller droplet size
→clouds last longer
→ increase albedo
→ less precipitation
T↑
Black carbon
Sulfate
organic carbon
T↓
pollutant sources
Surface of the Earth

Fine (PM2.5) and ultrafine particles (UFP) are the most biologically active

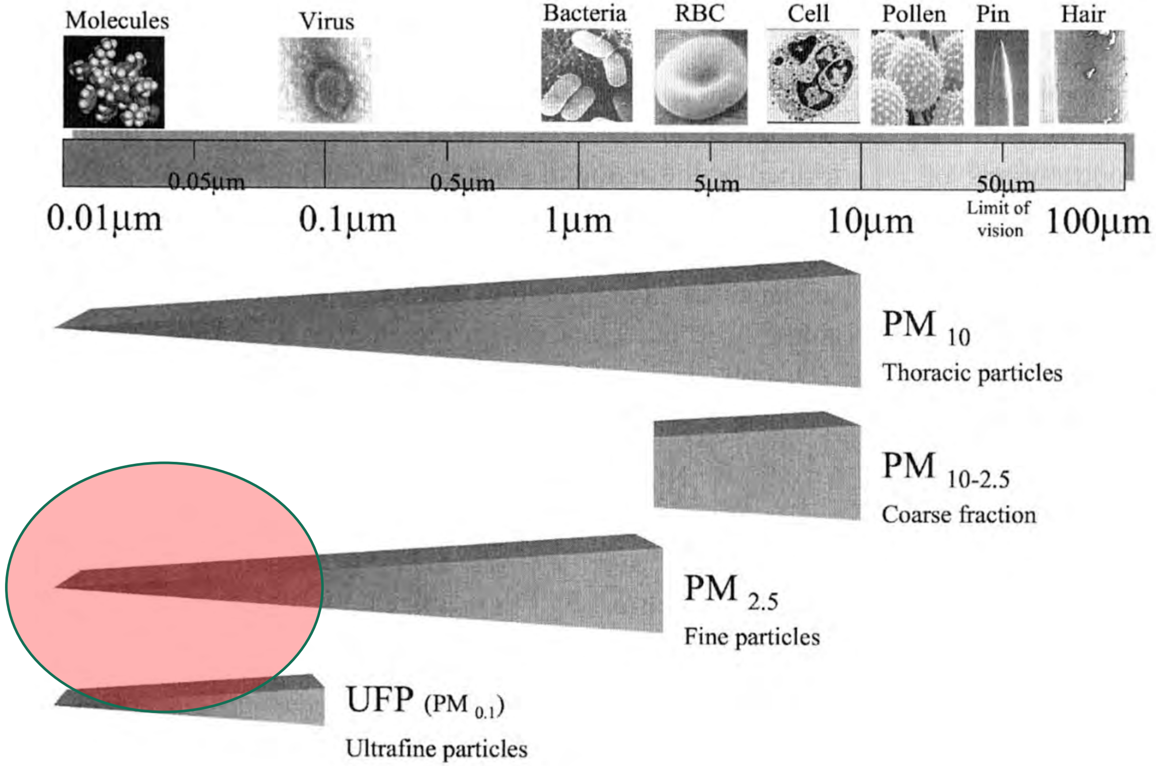


Figure 1. Particulate matter air pollution size distribution.

Combustion Sources Produce Toxic Air Contaminants

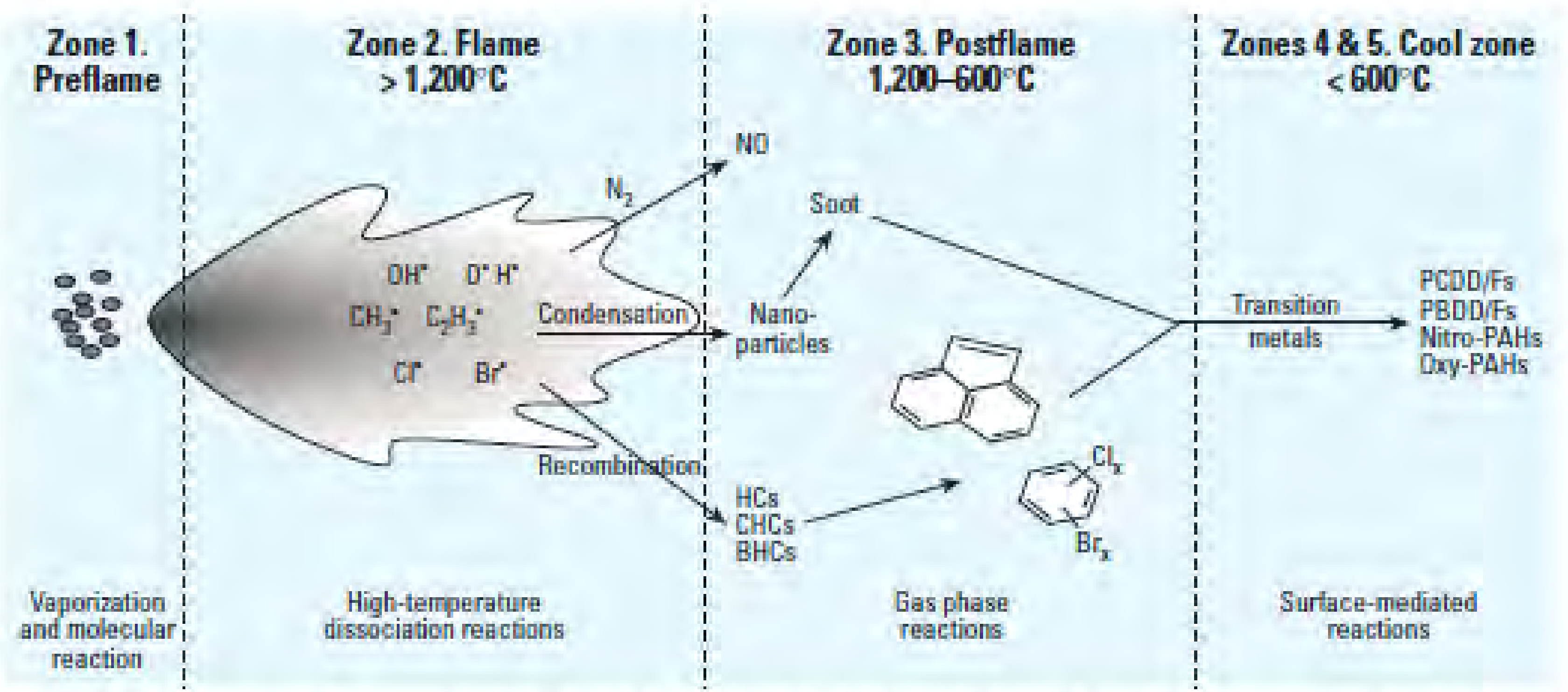


Figure 1. Combustor reaction zones. Zone 1, preflame, fuel zone; zone 2, high-temperature, flame zone; zone 3, postflame, thermal zone; zone 4, gas-quench, cool zone; zone 5, surface-catalysis, cool zone. PBDD/Fs, polybrominated dibenzo-*p*-dioxins and dibenzofurans. Reaction products from upstream zones pass through downstream zones and undergo chemical modifications, resulting in formation of new pollutants. Zone 2 controls formation of many "traditional" pollutants (e.g., carbon monoxide, sulfur oxides, and nitrogen oxides). Zones 3 and 4 control formation of gas-phase organic pollutants. Zone 5 is a major source of PCDD/Fs and is increasingly recognized as a source of other pollutants previously thought to originate in zones 1–4.

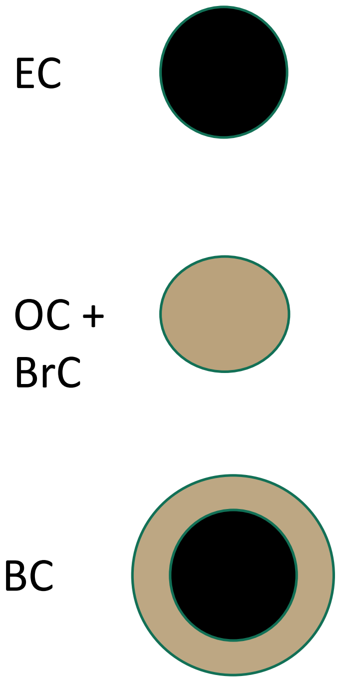
Origin and Health Impacts of Emissions of Toxic By-Products and Fine Particles from Combustion and Thermal Treatment of Hazardous Wastes and Materials

Stephania A. Cormier,[1] Slawo Lomnicki,[2] Wayne Backes,[3] and Barry Dellinger[2]

[1]Department of Biological Science, and [2]Department of Chemistry, Louisiana State University, Baton Rouge, Louisiana, USA; [3]Department of Pharmacology, Louisiana State University Health Sciences Center, Baton Rouge, Louisiana, USA

PM2.5 and UFP From Combustion Sources is a Mixture of Solid and Liquid Droplets that we call "SOOT"

- Black carbon (BC) is a major component of "soot", a complex light-absorbing mixture that comprised of a mixture of Elemental Carbon (EC) and Particulate Organic Carbon (OC).
- BC is the most strongly light-absorbing component of particulate matter (PM), and is formed by the incomplete combustion of fossil fuels, biofuels, and biomass.
- BC is emitted directly into the atmosphere in the form of fine particles ($PM_{2.5}$) and ultrafine particles ($PM_{0.1}$). These are also considered nanoparticles.
- BC is the most effective form of PM, by mass, at absorbing solar energy: per unit of mass in the atmosphere, BC can absorb a million times more energy than carbon dioxide (CO_2).
- Organic carbon aerosols are a significant absorber of solar radiation. The absorbing part of organic aerosols is referred to as "brown" carbon (BrC).



http://www.epa.gov/blackcarbon/basic.html

1 in 6 deaths, worldwide, is attributable to Pollution

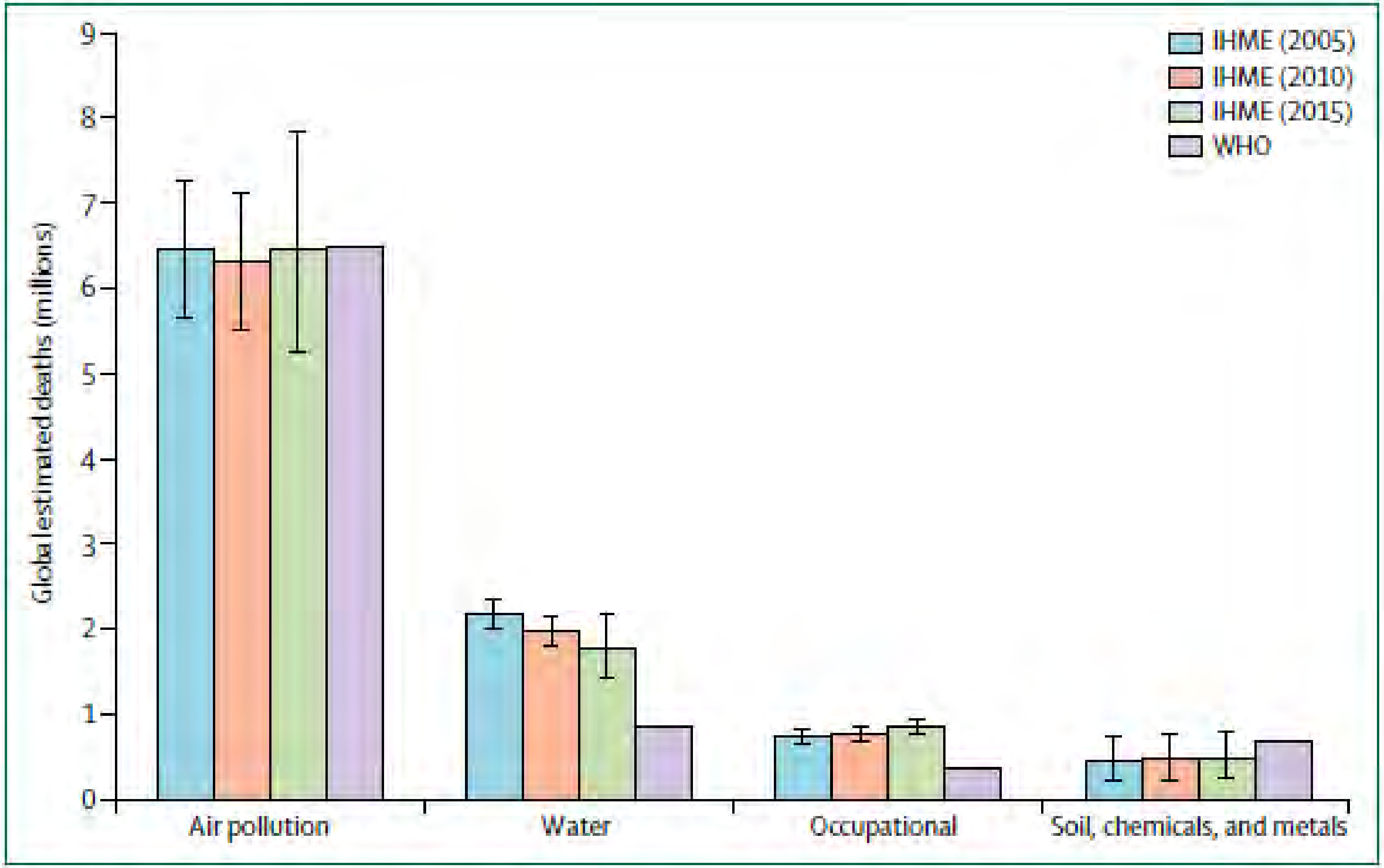


Figure 4: Global estimated deaths (millions) by pollution risk factor, 2005–15
Using data from the GBD study[41] and WHO.[39] IHME=Institute for Health Metrics and Evaluation.

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Air Pollution Contributes to Multiple Diseases

The *Lancet* Commission on pollution and health, Lancet, October 2017

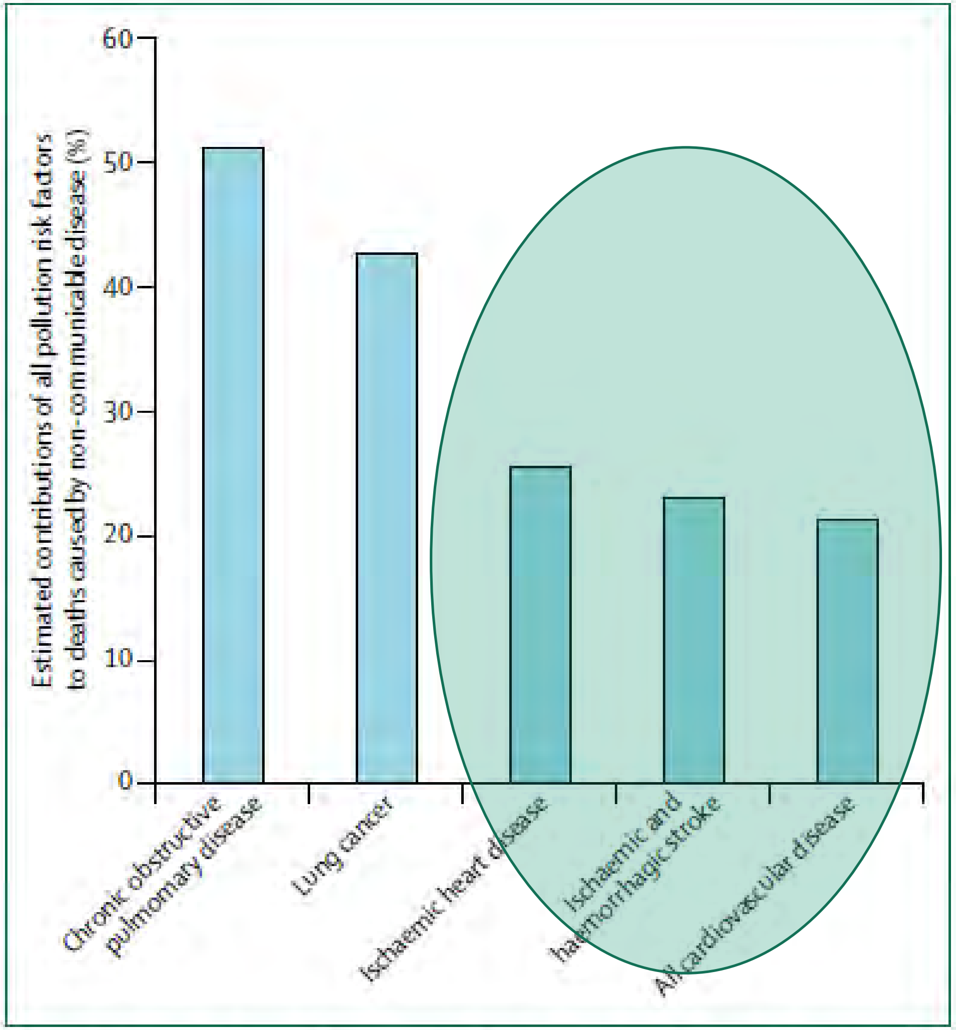

Figure 6: Estimated contributions of all pollution risk factors to deaths caused by non-communicable diseases, 2015

GBD Study, 2016.[42]

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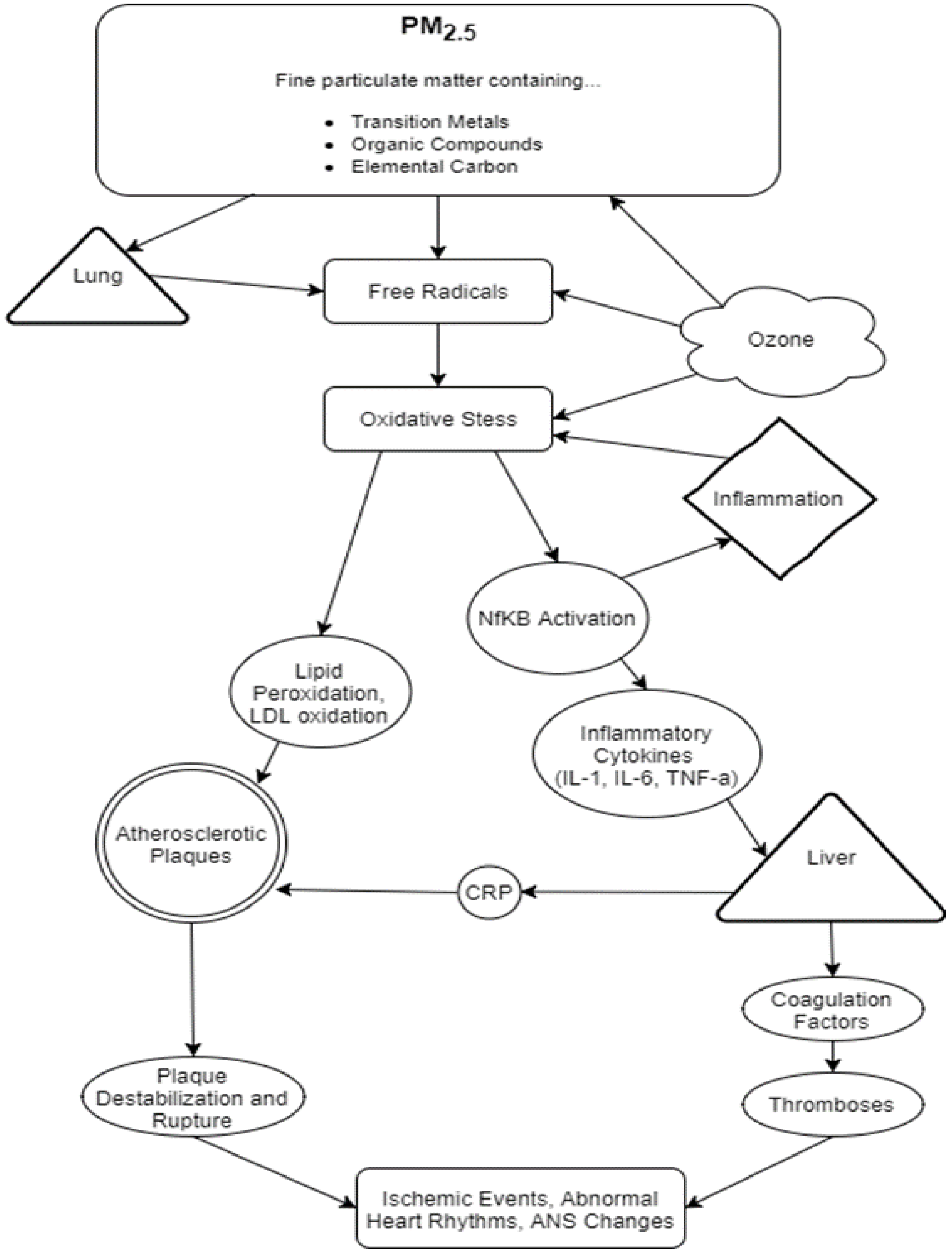
A Mechanistic Framework for PM2.5 Effects Leading to Cardiovascular Disease



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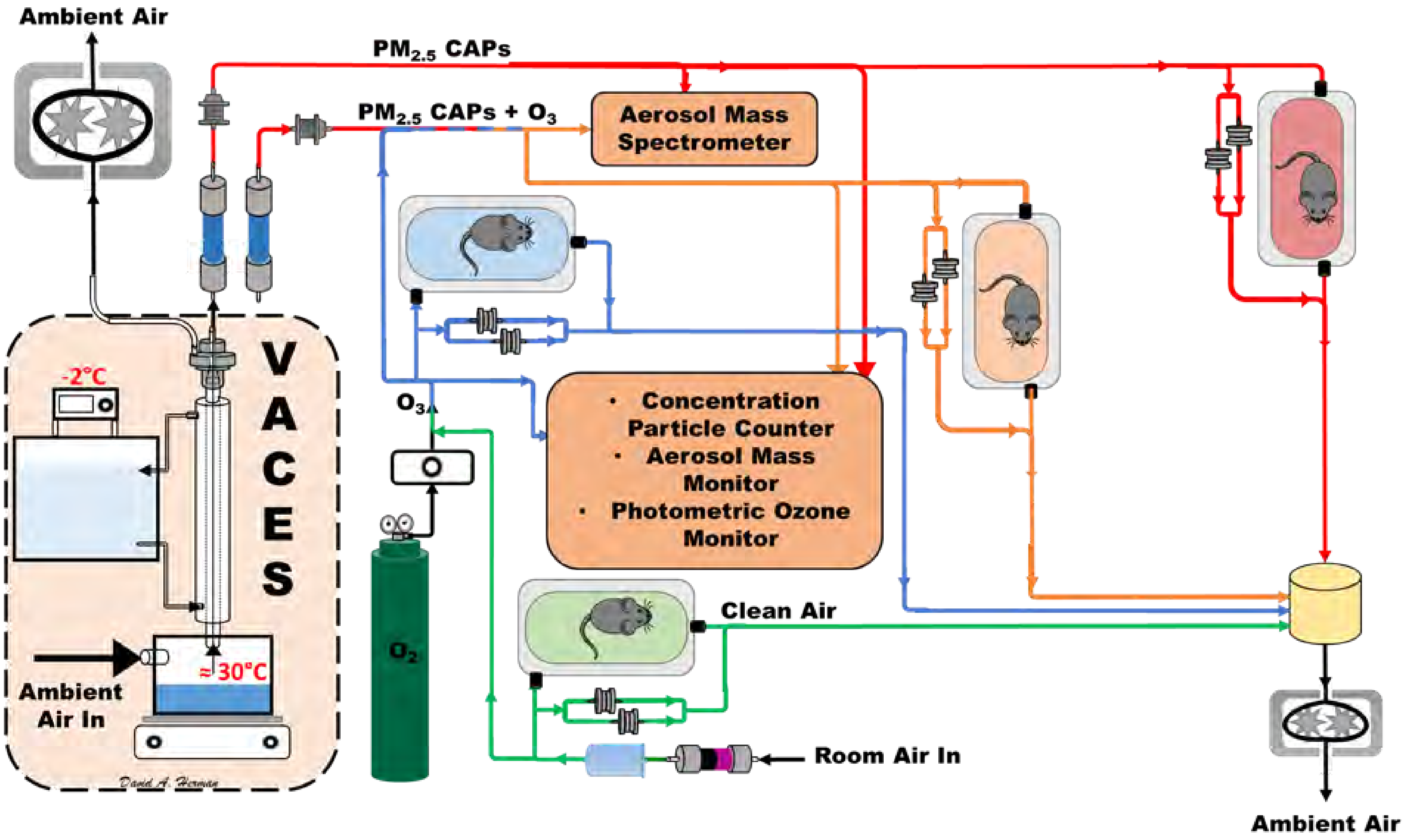
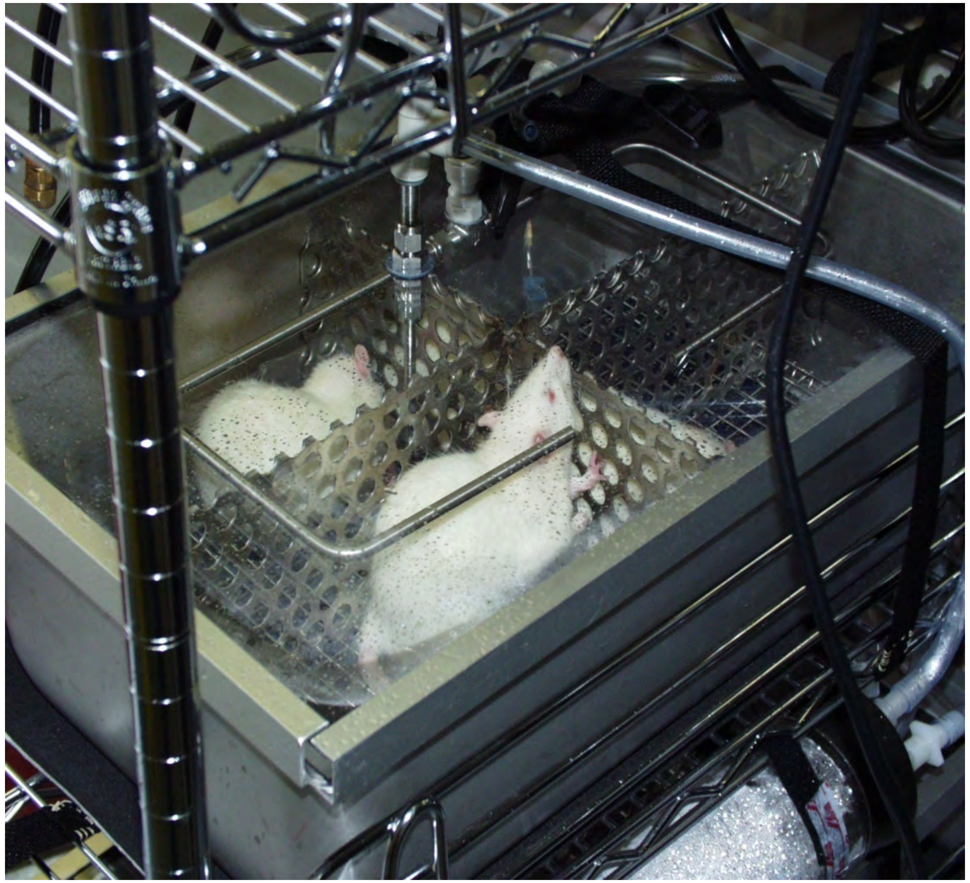
We can examine the health effects of specific pollutants using controlled exposures and help understand the mechanisms by which PM causes or worsens cardiovascular diseases.



C83

Rats or Mice Can Be Exposed to Purified Air or CAPs in Sealed Chambers

The Sealed Chambers Can Be Placed Onto Racks to Facilitate Transport



ECG and Blood Pressure Telemetry Devices can be Implanted to provide physiology data before, during and after exposures.

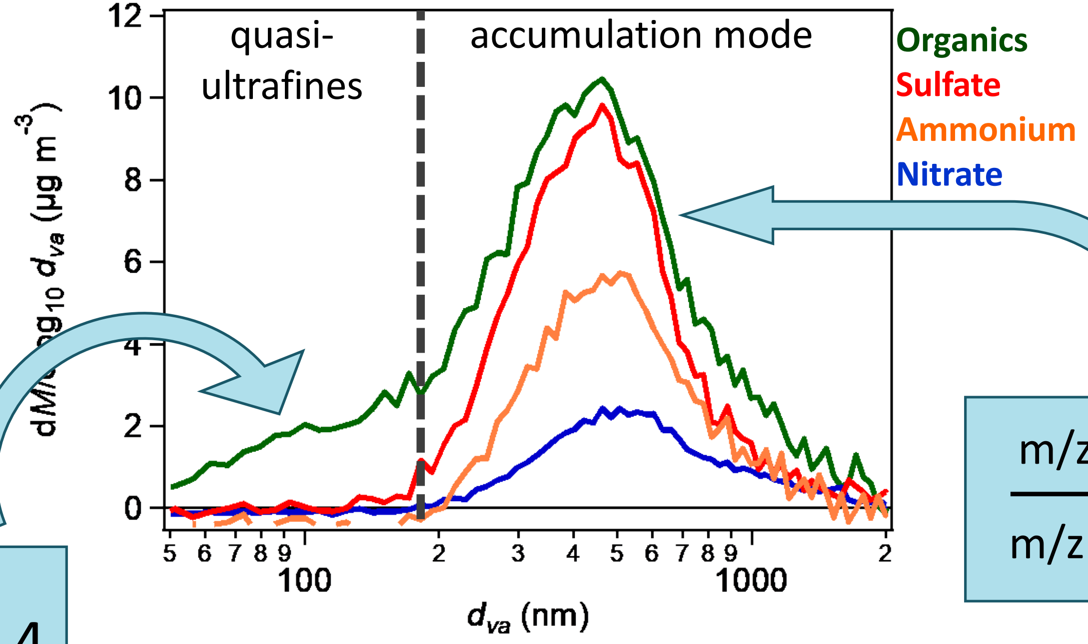
Exposure Protocol

- ApoE-/- mice were surgically implanted with ECG telemetry devices.
- Mice were exposed 5 hr per day (8AM to 1 PM) 4 days per week for 8 weeks at UC Irvine and were housed in filtered air-supplied caging systems between exposures.
- ECG data were monitored during exposures and while the mice were in housing (21 hr / day).
- All animal protocols were approved by the Institutional Animal Care and Use Committee.

What Happens When You Denude Quasi-Ultrafine CAPs (d_p < 180 nm)?

- Particle number and mass are reduced.
- Refractory constituents, such as heavy metals and elemental carbon, were only marginally affected by heating.
- Labile species such as total and water soluble organic carbon and PAHs showed progressive loss in concentration with increase in TD temperature.

Health-related characteristics of Ultrafine PM



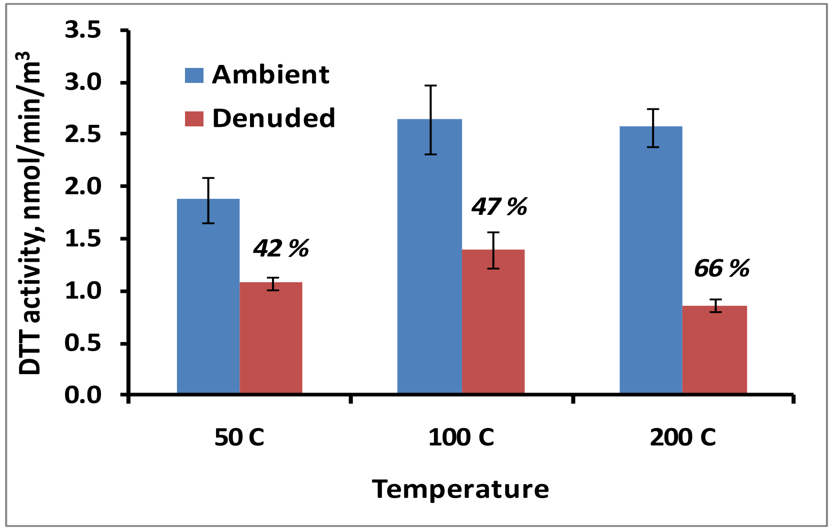
ultrafines
less oxygenated
(to denuder)

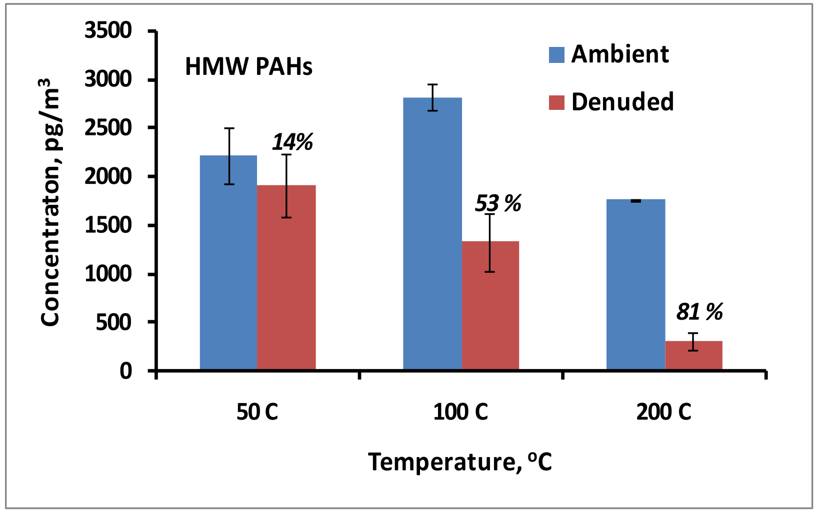
$$\frac{m/z\ 44\ (CO_2^+)}{m/z\ 55\ (C_4H_7^+)} \cong 0.4$$

larger particles
oxygenated

$$\frac{m/z\ 44\ (CO_2^+)}{m/z\ 55\ (C_4H_7^+)} \cong 4$$

When you denude the UFP





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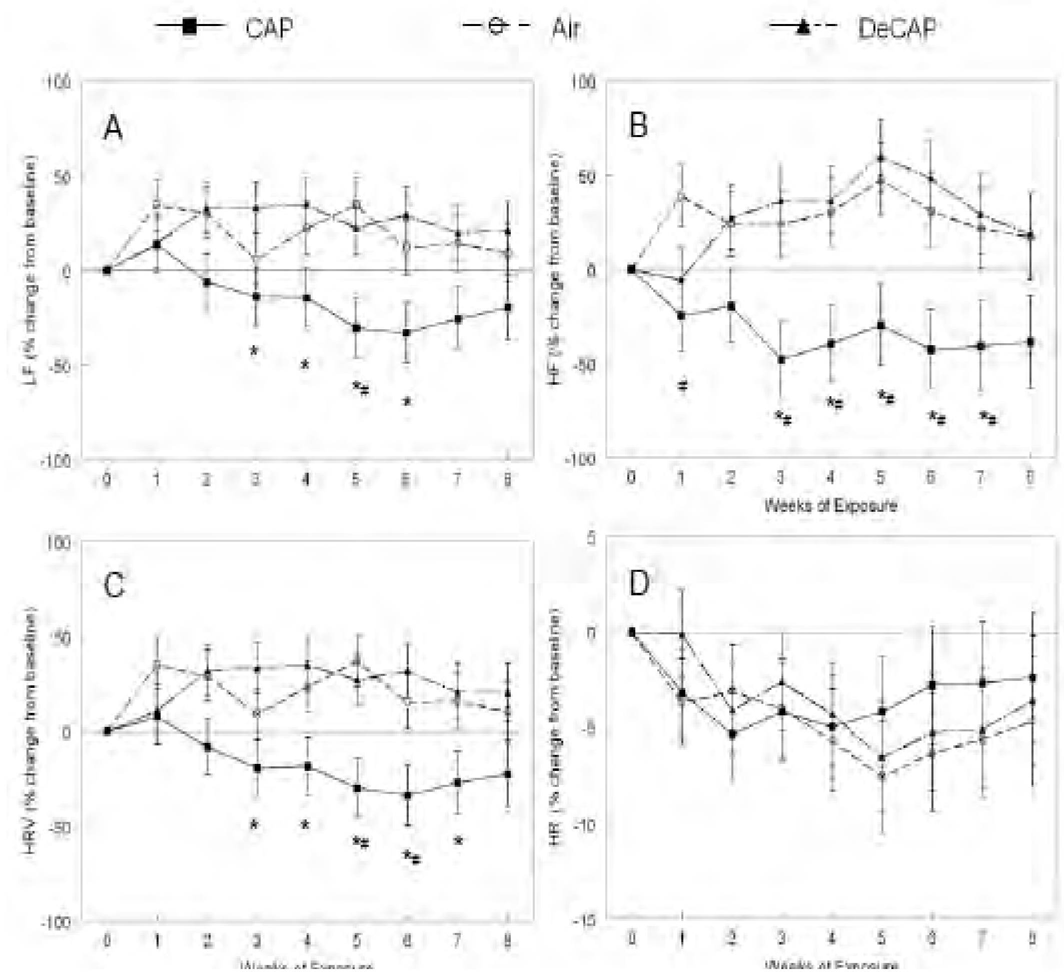
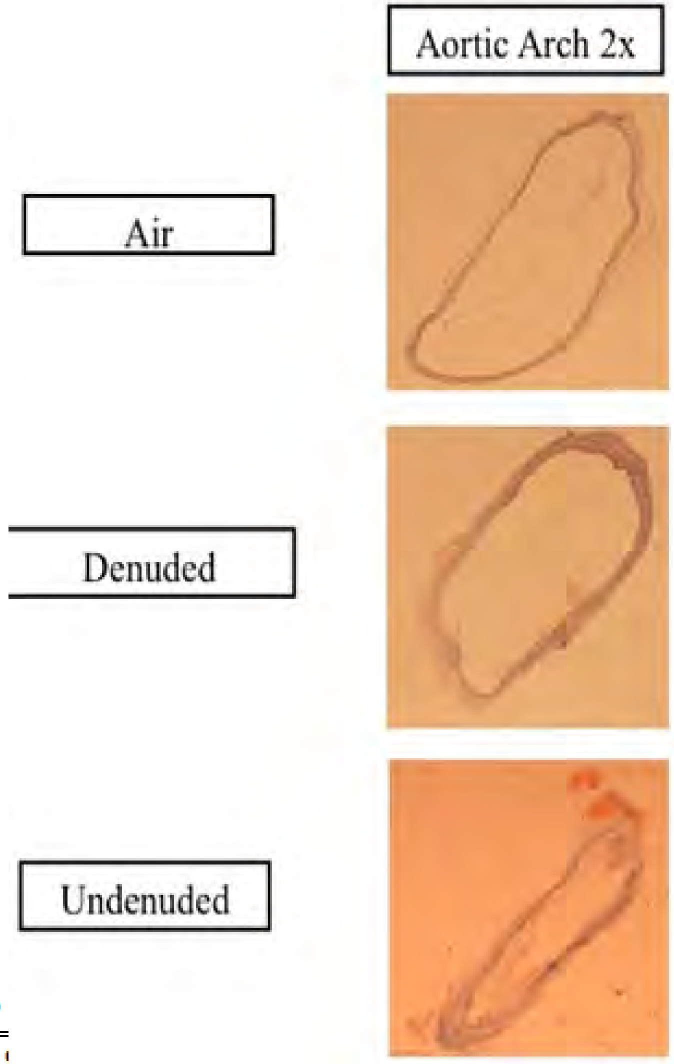
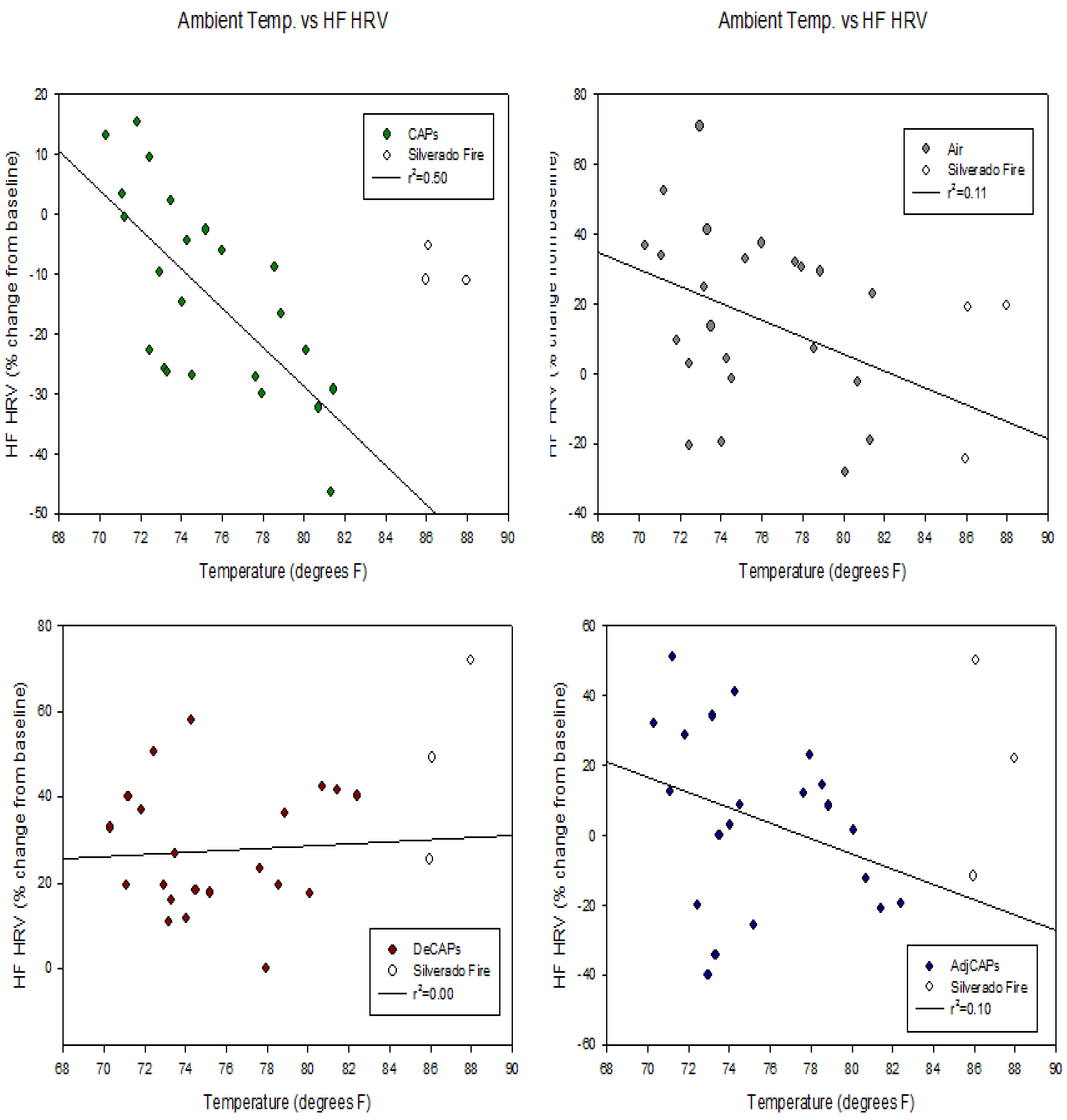
Removing the Organic Constituents From Ambient UFP Blocks CV Effects





	Air	CAP	deCAP
Plaque Size (% area of plaque in of total lumen CS)	14.5 ± 6.3	29.9 ± 10.0*	2.3 ± 0.
Lipid Accumulation (% area of lipid in total tissue CS)	5.1 ± 3.3	8.9 ± 2.4,#	2.2 ± 0.3
Lipid Peroxidation (nM MDA/mg protein)	134 ± 29	218 ± 32*,**	141 ± 17



These data show an association between ambient temperature and toxicity measured using heart rate variability (HRV).

The composition of the particles, which determines particle toxicity, is a function of atmospheric chemical reactivity, which is dependent on temperature and photochemical processes.

Conclusions

- PM exposures can exacerbate lung disease, heart disease and cancer
- UFP and PM2.5 contain toxic components and carcinogens
- Children, elderly and Individuals with pre-existing lung and heart conditions are at elevated risk
- The human studies and the toxicology studies support the premise that PM can be mechanistically and causally linked to cardiovascular health effects.

Funding Sources

- Research using advanced instrumentation (AMS and SMPS) was through AirUCI and funded by the National Science Foundation

California Environmental Protection Agency
AIR RESOURCES BOARD

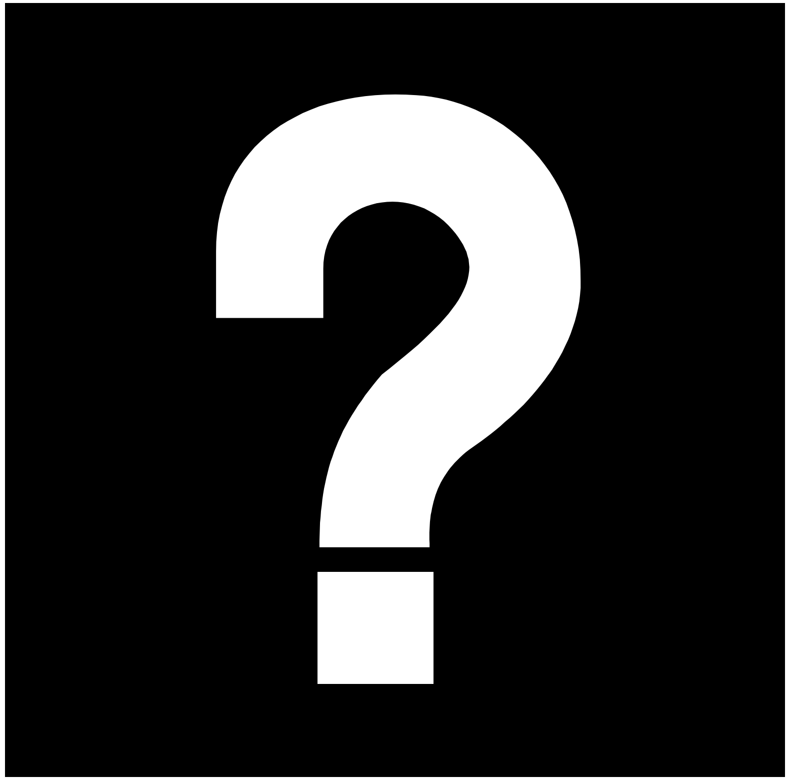
Moving the AMS is a group effort!

Health studies at are currently sponsored by the California Air Resources Board, the South Coast Air Quality Management District and the NIEHS

NIH National Heart, Lung, and Blood Institute

NIEHS National Institute of Environmental Health Sciences

Questions and Discussion



Particulate Matter:

Spotlight on Health Protection

John R. Balmes, M.D.

- Professor of Medicine at UC San Francisco
- Professor of Environmental Health Sciences in the School of Public Health at UC Berkeley
- Director of the Northern California Center for Occupational and Environmental Health
- Authored over 300 papers on occupational and environmental health-related topics
- Physician Member of the California Air Resources Board

Particulate Matter Health Effects: What Do We Know and What Do We Still Need to Know?

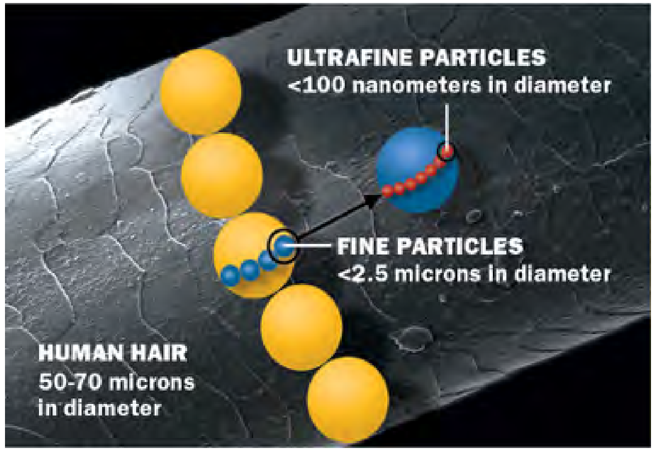
John R. Balmes, MD
University of California,
San Francisco and Berkeley

Outline

- Particulate Pollution
  - What Do We Know
  - New Evidence
- Exposure Inequality
  - Cumulative Risk
- Wildfire PM
  - Cardiovascular Risk

Ambient Particulate Matter (PM)

- PM is a mixture, including particles of differing origin (combustion, crustal, biological) and varying size.
- Multiple sources
  - Ultrafines ($PM_{<0.1}$): Fuel (including biomass) combustion
  - $PM_{2.5}$: Fuel (including biomass) combustion
  - $PM_{10-2.5}$: Road dust, crustal, and biological material



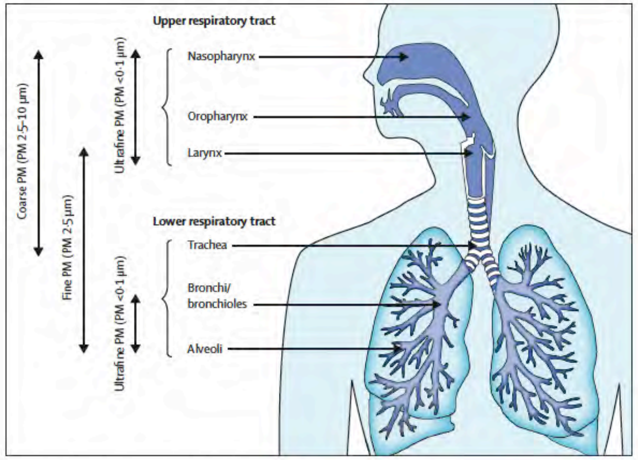


Figure 4: Compartmental deposition of particulate matter

Particulate Matter: Health Effects

- Asthma
  - Exacerbation
  - New-onset
- Decreased lung function growth
- Mortality
  - Ischemic heart disease
- Lung cancer

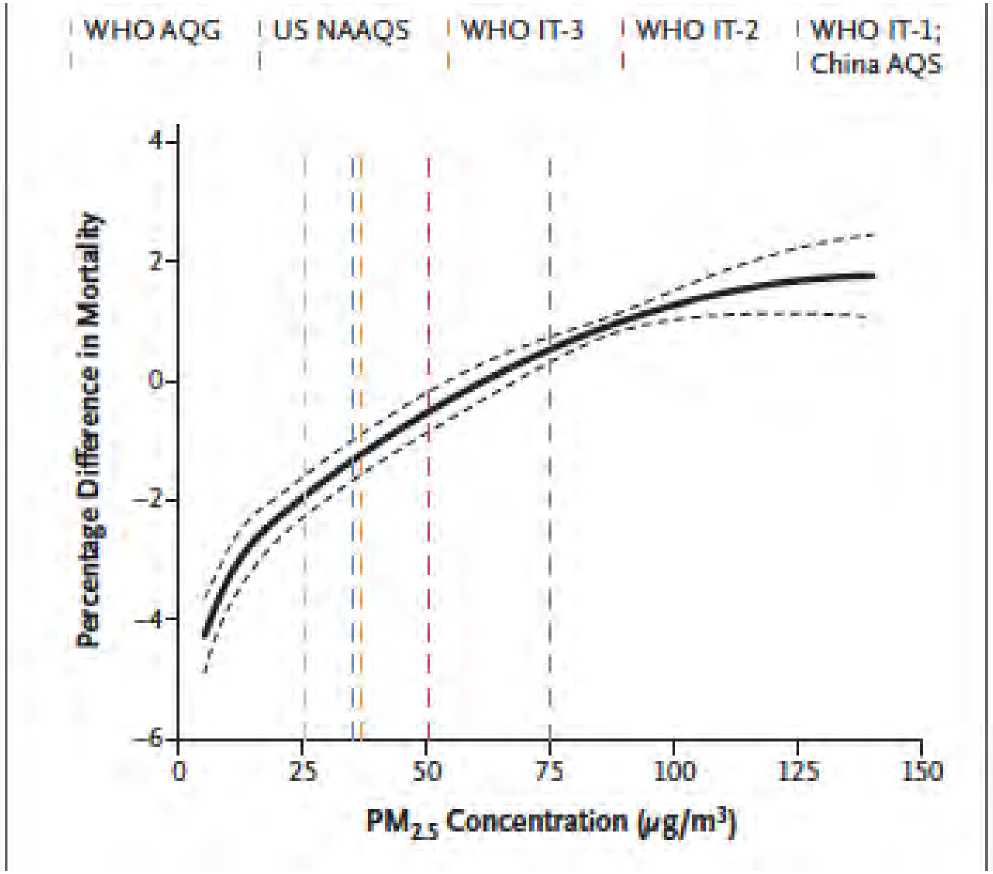
Key Questions

- Are current PM standards sufficiently protective?
  -- No margin of safety
- How has the PM health evidence been strengthened?
  – New evidence of mortality effect at levels below the current NAAQS

The NEW ENGLAND JOURNAL of MEDICINE

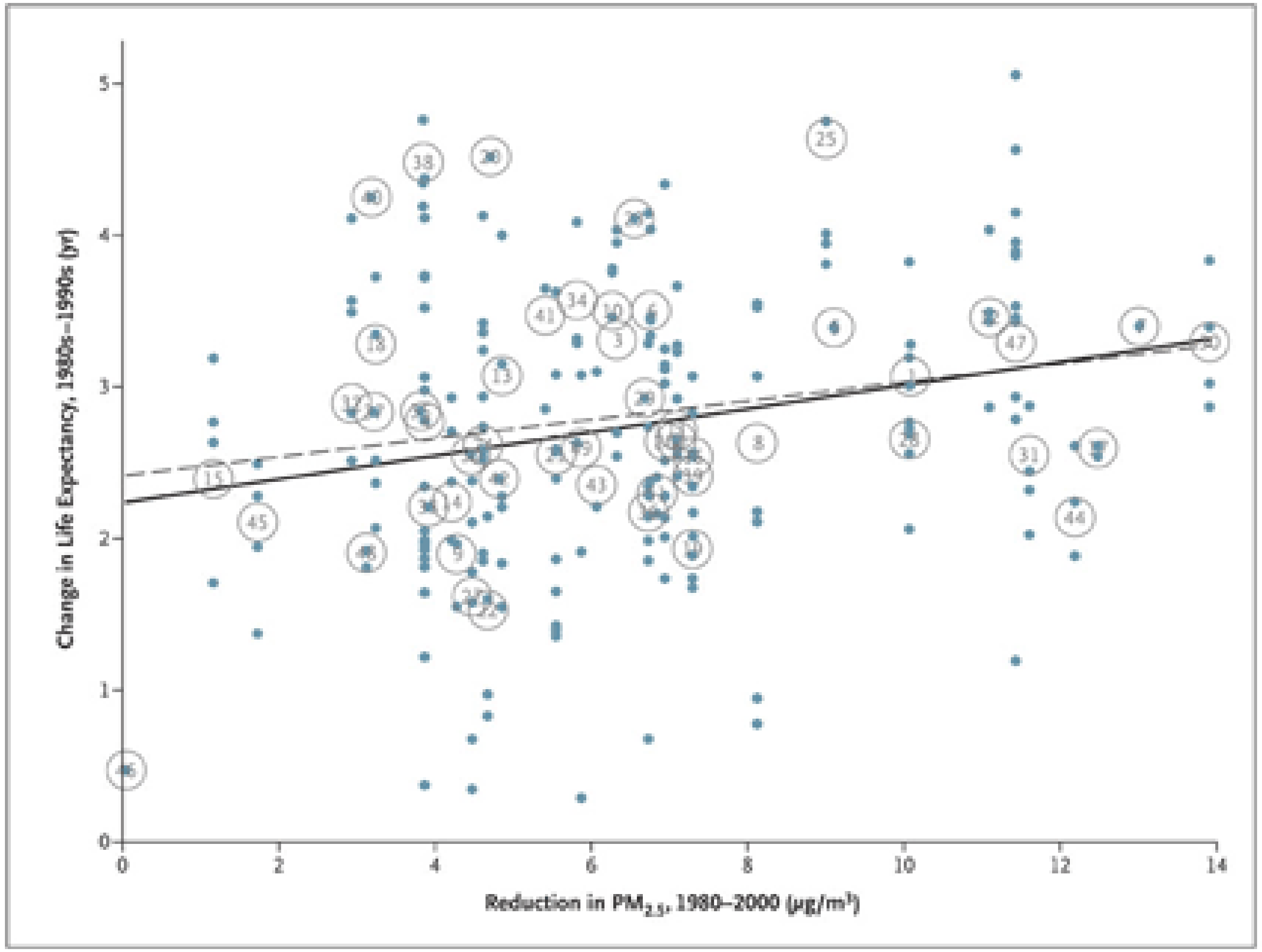
ESTABLISHED IN 1812 AUGUST 22, 2019 VOL. 381 NO. 8

Ambient Particulate Air Pollution and Daily Mortality in 652 Cities



C100

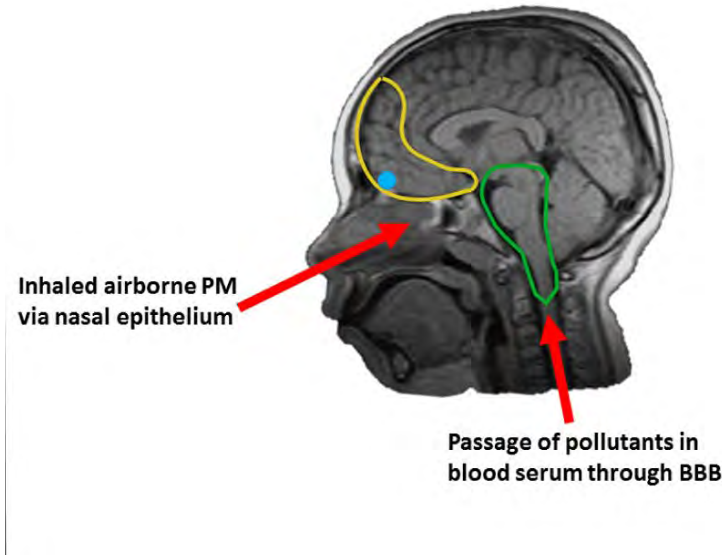
Fine-Particulate Air Pollution and Life Expectancy in the United States



Pope et al. N Engl J Med 2009;360:376-386.

Key Questions

- What new health effects are now recognized?
  - Adverse birth outcomes
  - Metabolic effects
  - Neurological effects



What is role of ultrafine particles (UFP)?

- UFP (PM<0.1µm) are generated both as primary emissions from combustion processes and as secondary products of atmospheric chemistry
- Toxicological studies suggest UFP are a high-risk hazard, but epidemiological data are sparse because there is no monitoring network

Key Questions

- Are there "new" sensitive groups?
  - Children
  - People of color and low SES
- How should we account for spatial scale of effects (i.e., regional versus local-scale impacts, including proximity to major sources)?

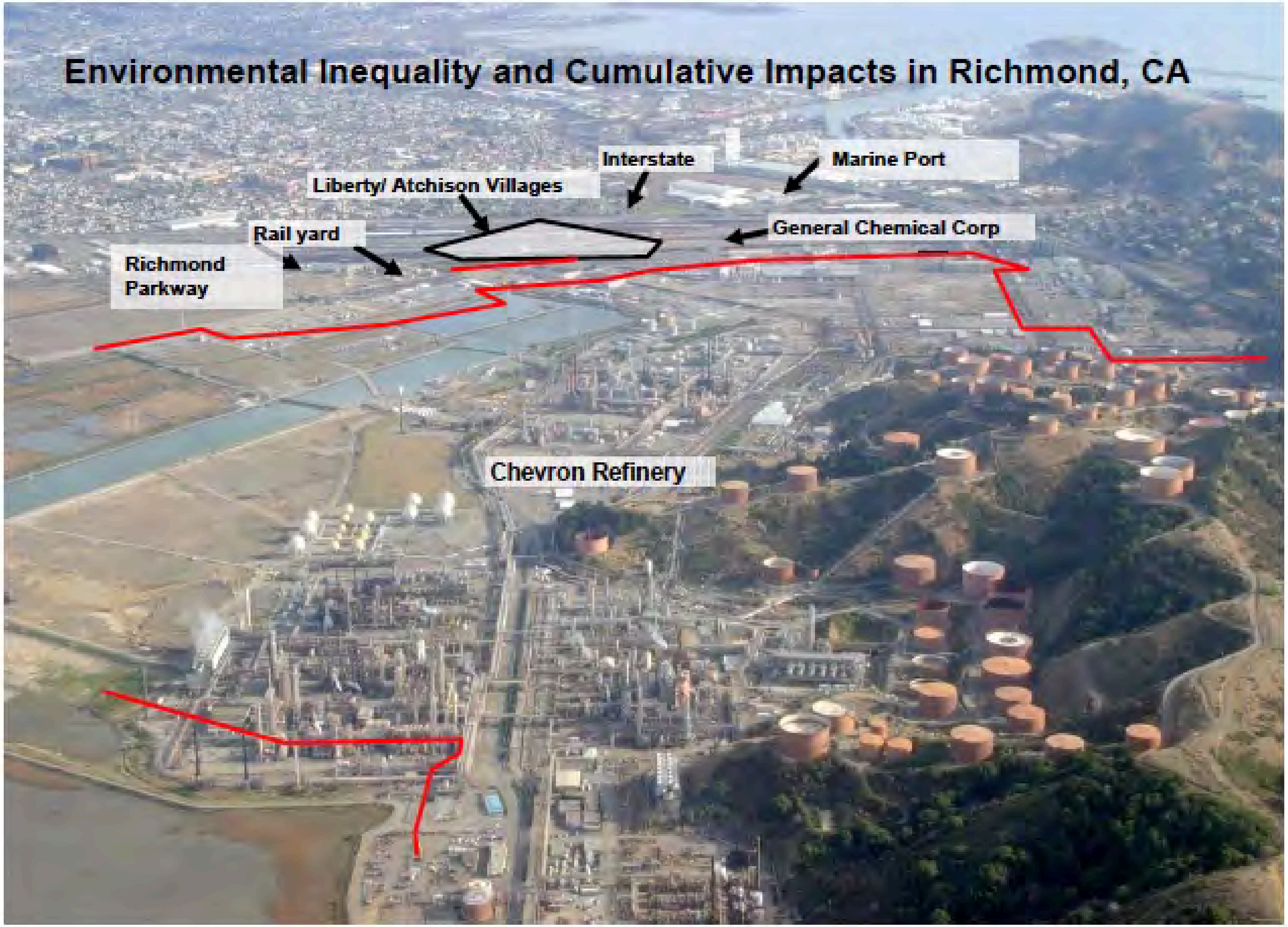
Demographics of Children Living Near Freeways

– Children of color 3x more likely to live near high traffic density in California

Gunier et al., California Dept of Health Services, 2003

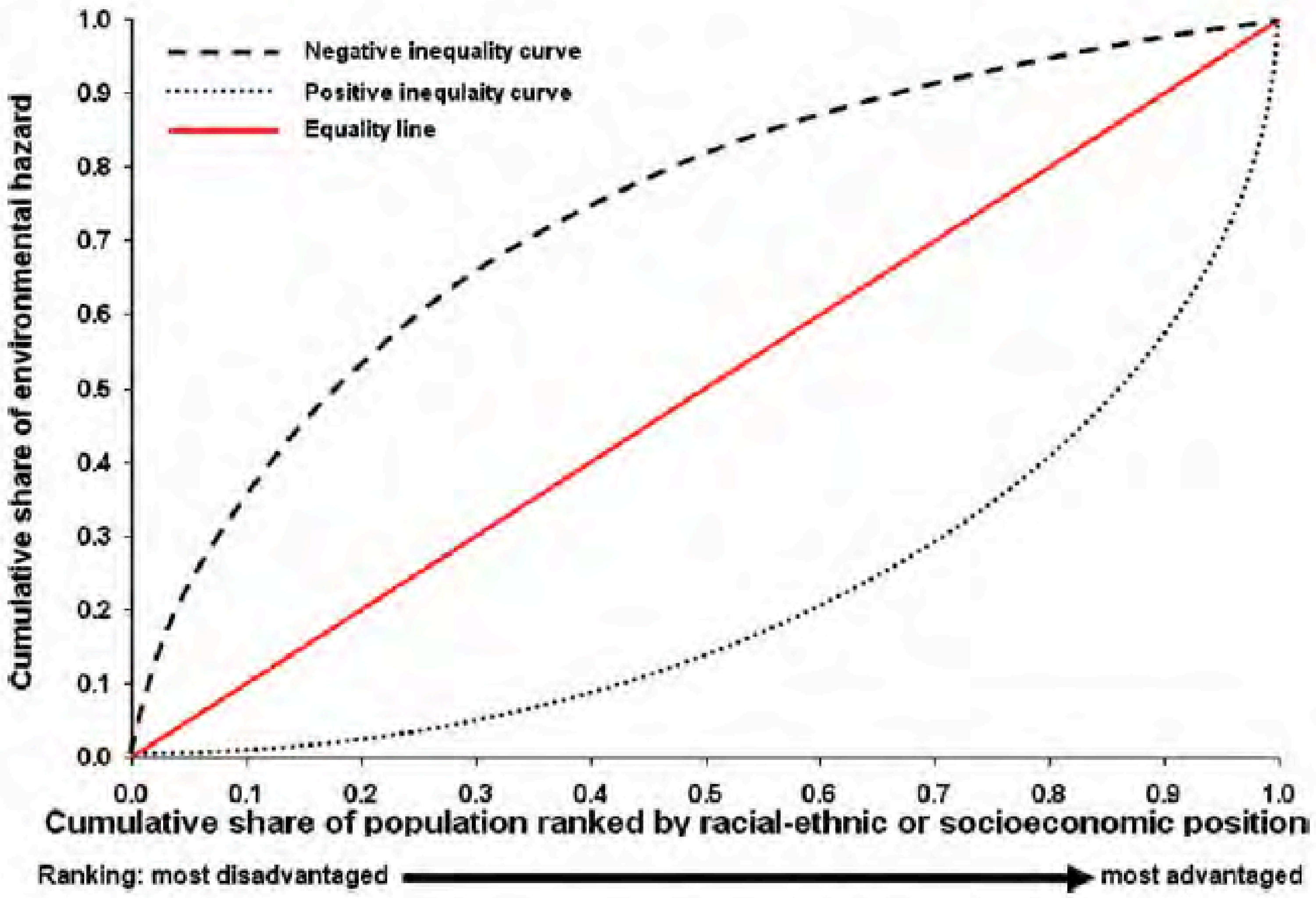
– Schools near busy roads have a disproportionate number of children who are economically disadvantaged and non-white

RS Green et al, Environ Health Perspect 2004;112:61.


Environmental Inequality and Cumulative Impacts in Richmond, CA
Interstate
Marine Port
Liberty/ Atchison Villages
Rail yard
General Chemical Corp
Richmond Parkway
Chevron Refinery

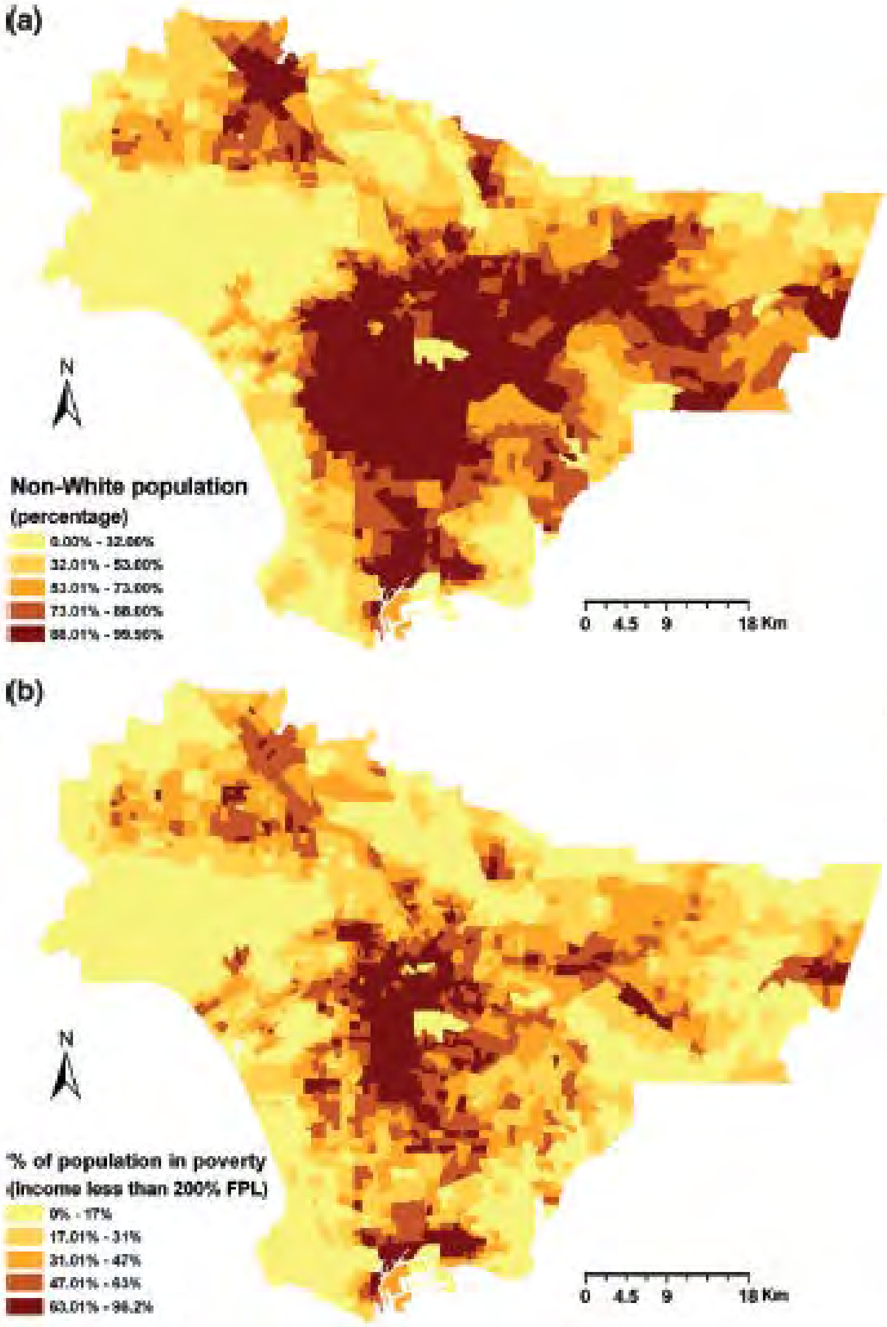
C106

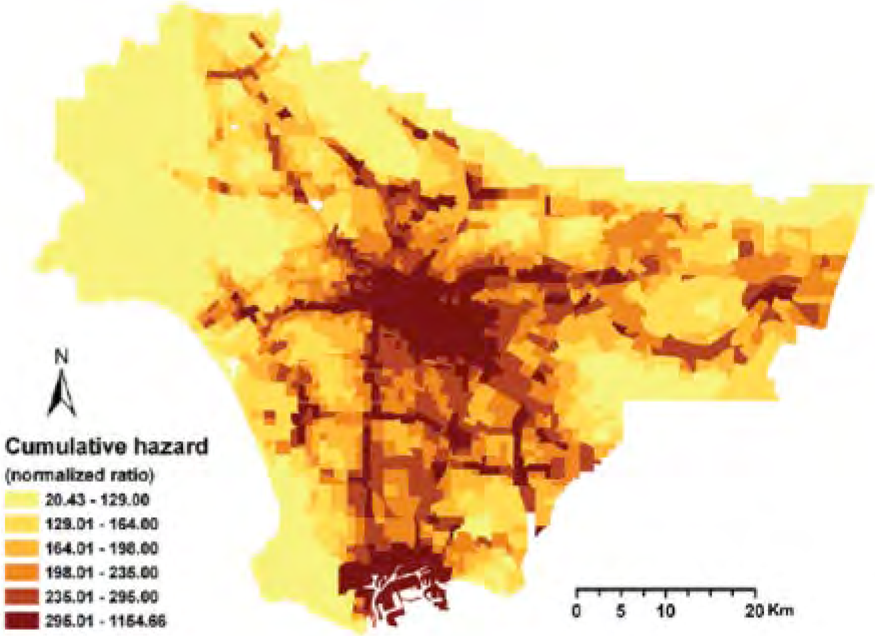
Inequality Curve



Environ Sci Technol 2009;43:7626–34.

C107





Environ Sci Technol 2009;43:7626–34.

C108 76

Cumulative Risk

- People of color and low SES have
  - Greater exposures to outdoor partculate pollution
  - Disproportionate proximity to polluting land uses and toxic emissions
- Poor communities have more health-damaging factors and less health-promoting amenities
  - Less access to healthy food and health care
  - Less green space and recreational programs
  - Poor quality housing and greater violence

Key Questions

- What are health impacts of high-concentration acute events (e.g., wildfires)? How should we compare them to day-to-day PM impacts?

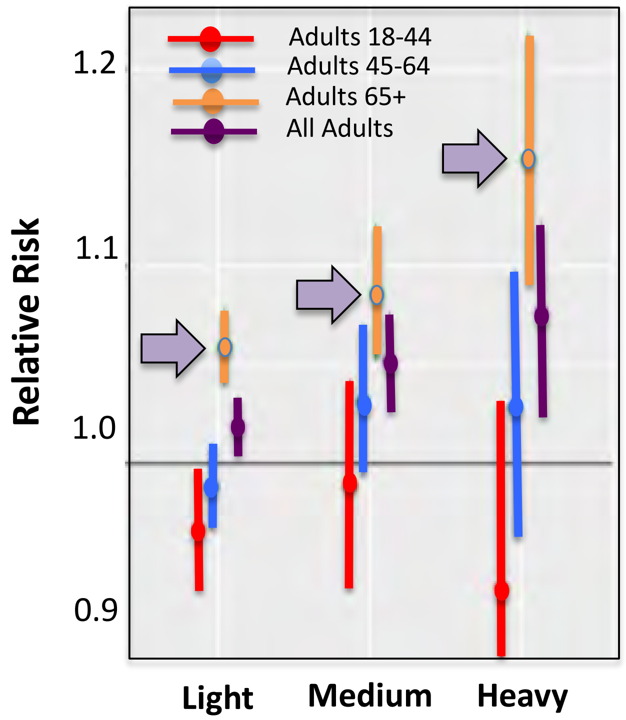
Clear evidence of an association between wildfire smoke and respiratory health

- Asthma exacerbations significantly associated with higher wildfire smoke ***in nearly every study***
- Exacerbations of chronic obstructive pulmonary disease (COPD) significantly associated with higher wildfire smoke in most studies
- Growing evidence of a link between wildfire smoke and respiratory infections (pneumonia, bronchitis)

Wildfire-$PM_{2.5}$ Increases Heart Attack & Stroke

- ***Wildfire-$PM_{2.5}$ associated with heart attacks and strokes for all adults, particularly for those over 65 years old***
- ***Increase in risk the day after exposure:***
  - All cardiovascular, 12%
  - Heart attack, 42%
  - Heart failure, 16%
  - Stroke, 22%
  - All respiratory causes, 18%
  - Abnormal heart rhythm, 24%
    (on the same day as exposure)

All Cardiovascular Causes



Wettstein Z, Hoshiko S, Cascio WE, Rappold AG et al. JAHA April 11, 2018

Slide credit: Wayne Cascio

Thank you

Particulate Matter:
Spotlight on Health Protection

H. Christopher Frey, Ph.D., F. A&WMA, F. SRA

- Glenn E. Futrell Distinguished University Professor of Environmental Engineering in the Department of Civil, Construction, and Environmental Engineering at North Carolina State University
- Adjunct professor in the Division of the Environment and Sustainability at the Hong Kong University of Science and Technology
- Fellow of the Air & Waste Management Association and of the Society for Risk Analysis
- Ph.D. in Engineering and Public Policy from Carnegie Mellon

Recent Developments in the Scientific Review of the National Ambient Air Quality Standards for Particulate Matter

H. Christopher Frey
frey@ncsu.edu

NC STATE UNIVERSITY

Department of Civil, Construction & Environmental Engineering
North Carolina State University
Raleigh, NC 27695

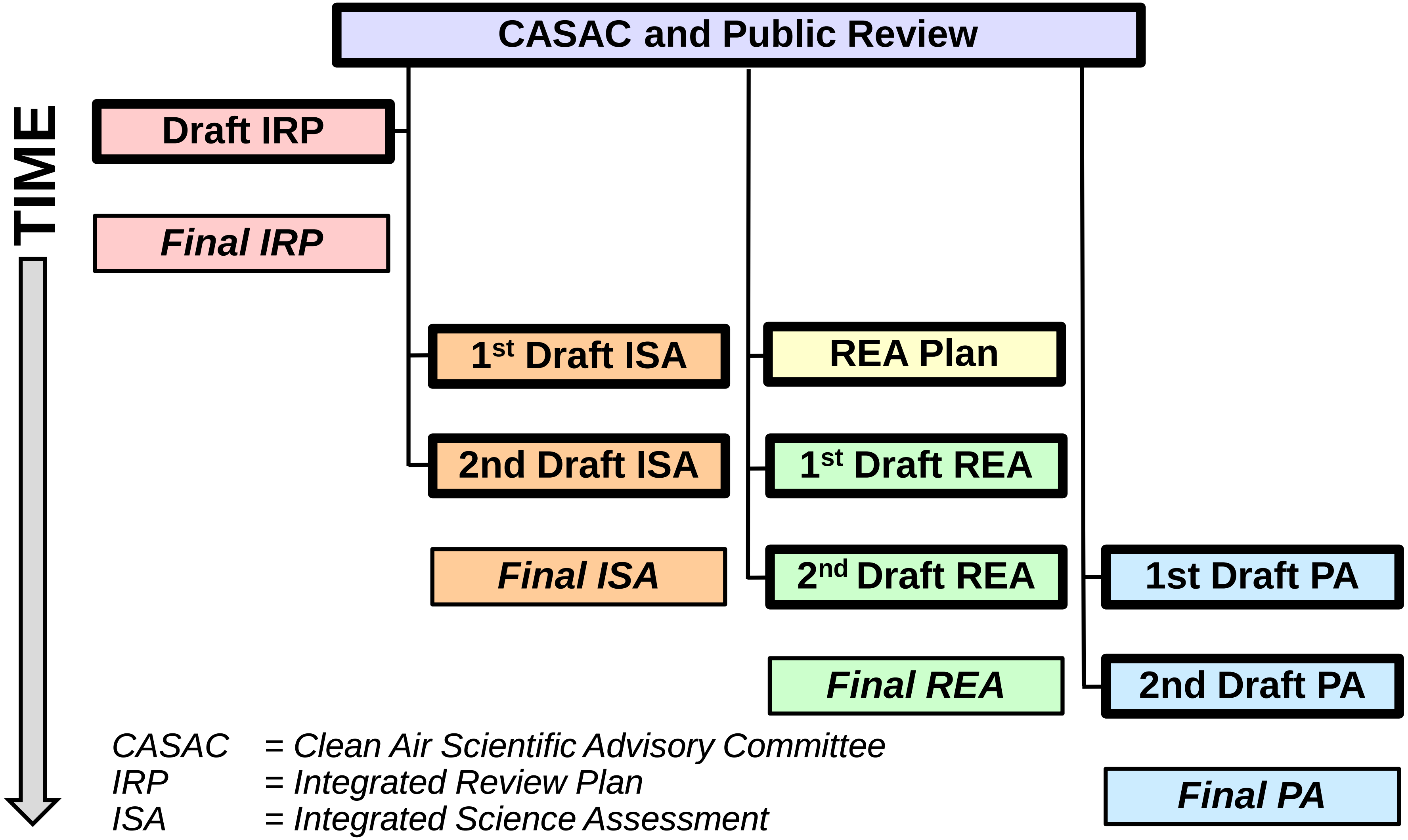
Presented at:
Particulate Matter: Spotlight on Health Protection
Bay Area Air Quality Management District
San Francisco, CA

October 28, 2019

Key Points

- The National Ambient Air Quality Standard (NAAQS) Science Review Process Worked Well Until 2017
- EPA Administrators Pruitt and Wheeler Have Broken the Process
- Particulate Matter Science Review By the EPA Clean Air Scientific Advisory Committee (CASAC) is Highly Deficient: Appropriate to Look Elsewhere
- Disbanded CASAC PM Review Panel Reconvened Itself
- Key Findings of the Independent Particulate Matter Review Panel

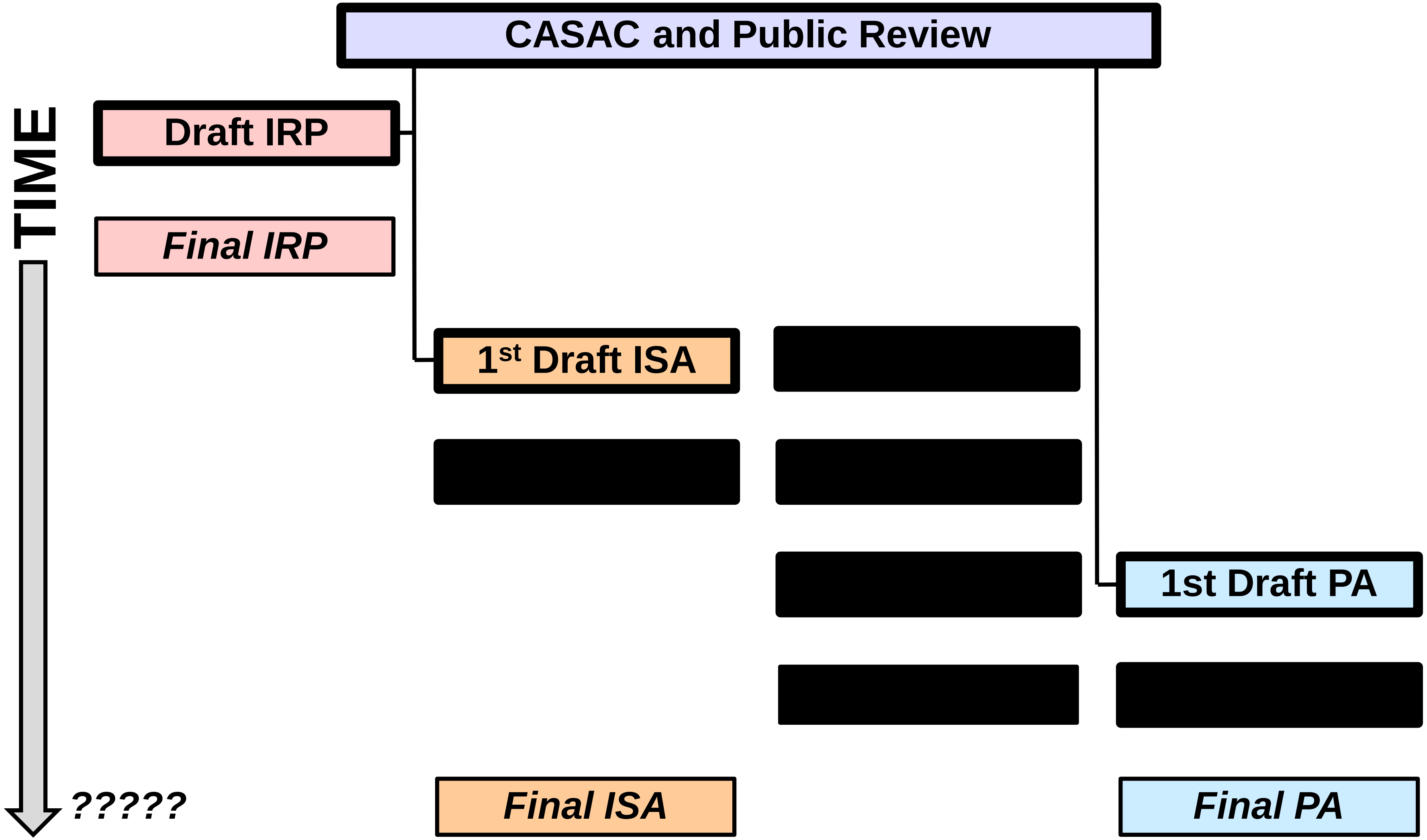
Generic "Full" National Ambient Air Quality Standard (NAAQS) Science Review from Document Perspective



CASAC = Clean Air Scientific Advisory Committee
IRP = Integrated Review Plan
ISA = Integrated Science Assessment
REA = Risk and Exposure Assessment
PA = Policy Assessment

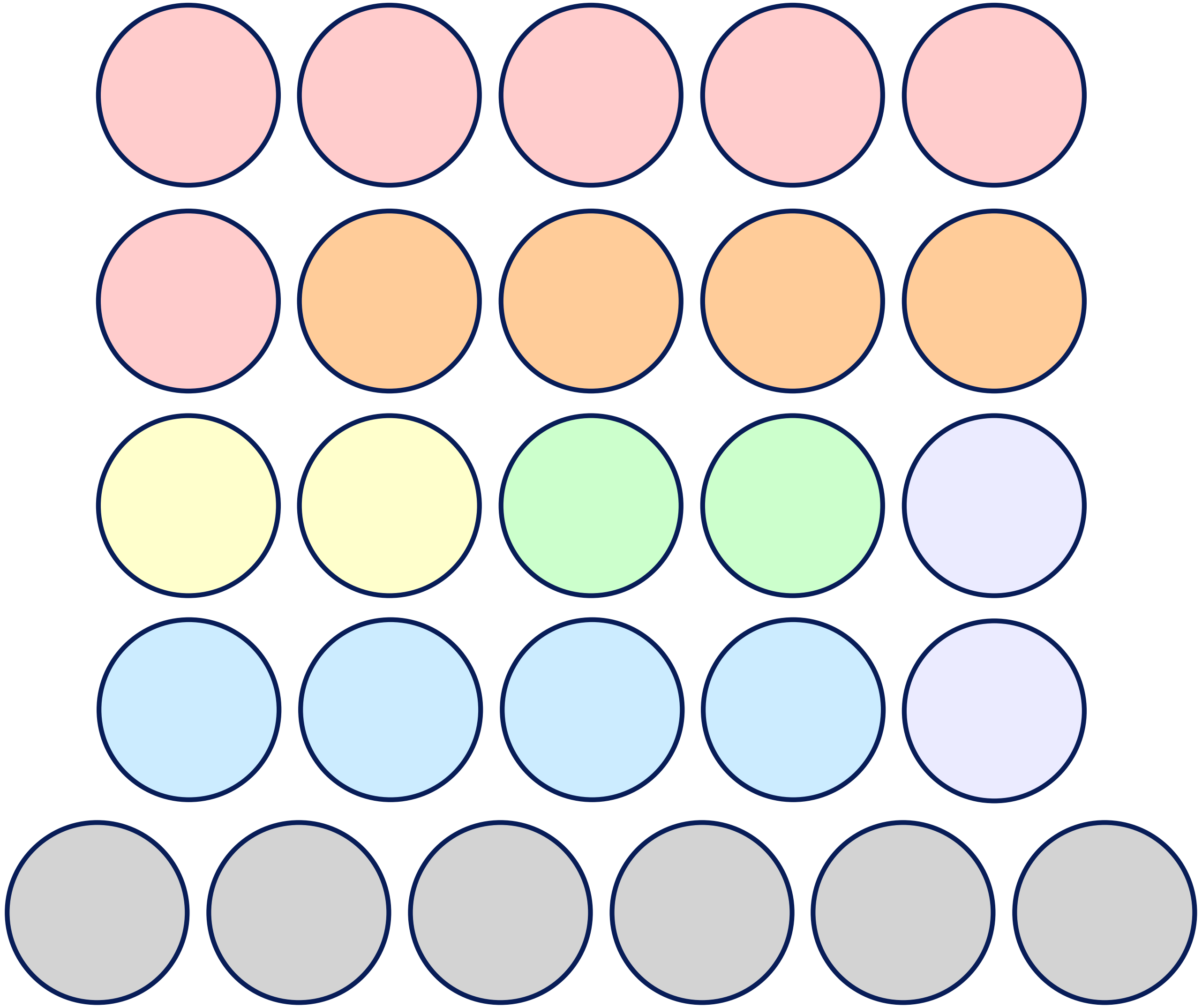
C118

Pruitt/Wheeler (P/W) Particulate Matter NAAQS Science Review from Document Perspective

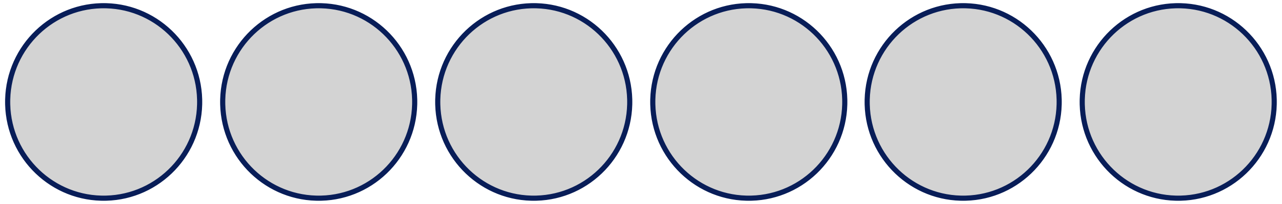


C119

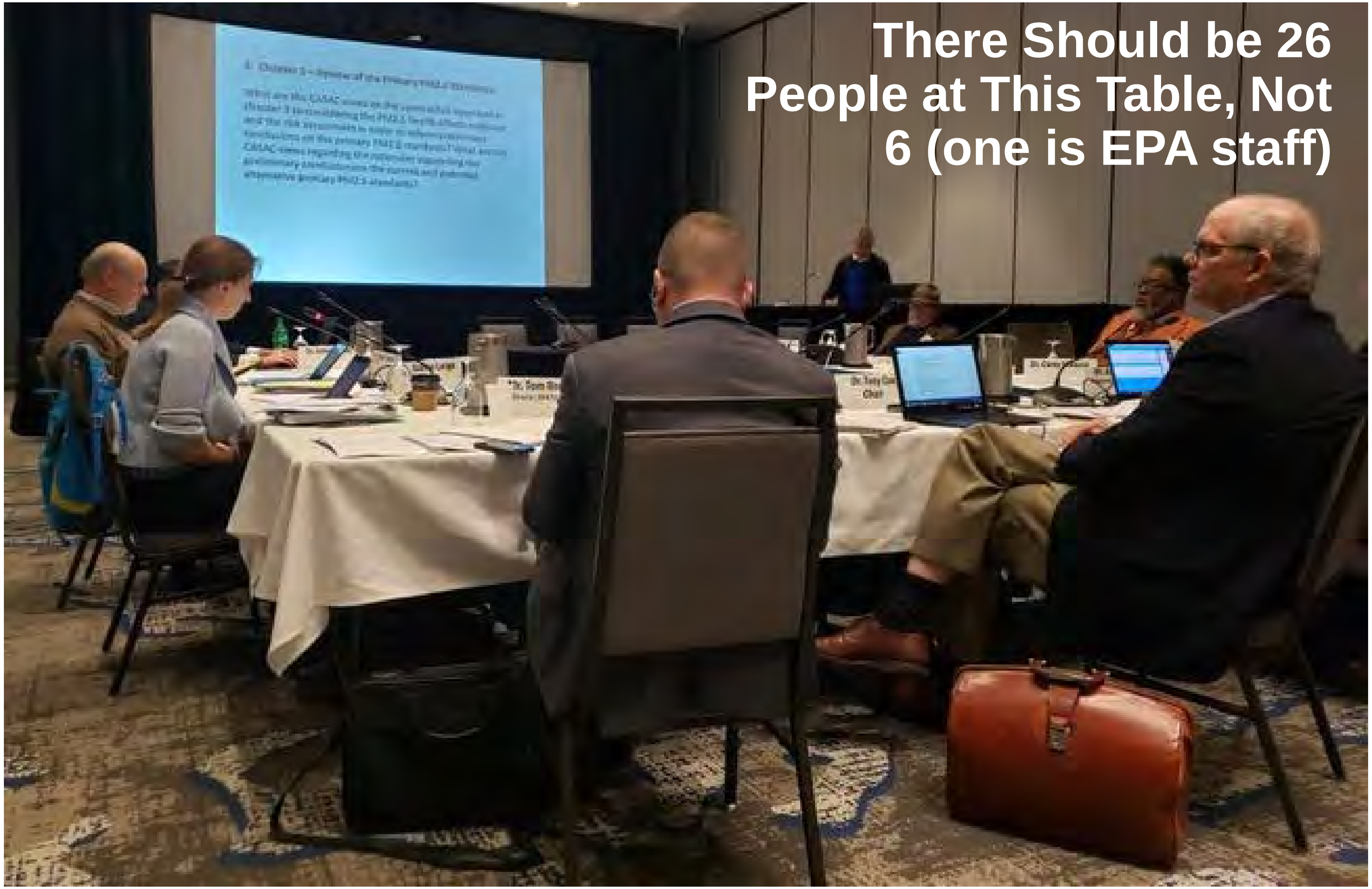
2015 EPA CASAC Particulate Matter Review Panel (26)



Pruitt/Wheeler EPA CASAC Particulate Matter Review Panel (6 last week, 7 by statute)



The Latest from CASAC, as of 2:25 pm Friday, October 25, 2019



C122

The Latest from CASAC, as of 2:25 pm Friday, October 25, 2019

- CASAC is split 4-2:
  - Four recommend keeping all current standards (primary $PM_{2.5}$, coarse PM, secondary $PM_{2.5}$) as is.
  - Rationales offered for keeping the annual primary $PM_{2.5}$ standard are ill-informed or inappropriate, given the state of the science, lack of needed expertise and obvious lack of understanding of the statutory mandate of the Clean Air Act.

Independent Particulate Matter Review Panel

- Formerly the CASAC PM Review Panel
- Disbanded October 10, 2018
- Met October 10, 2019 to October 11, 2019 in Crystal City, VA
- Follow-up Teleconference October 18, 2019 to finalize report

C124

Independent Particulate Matter Review Panel

- **Dr. H. Christopher Frey**, Chair, North Carolina State University
- **Dr. Peter Adams**, Carnegie Mellon University
- **Dr. John L. Adgate**, Colorado School of Public Health
- **Mr. George Allen**, NESCAUM
- **Dr. John Balmes**, University of California at San Francisco
- **Dr. Kevin Boyle**, Virginia Tech
- **Dr. Judith Chow**, Desert Research Institute
- **Dr. Douglas W. Dockery**, Harvard T.H. Chan School of Public Health
- **Mr. Dirk Felton**, NY State Dept. of Environmental Conservation
- **Dr. Terry Gordon**, New York University School of Medicine
- **Dr. Jack Harkema**, Michigan State University
- **Dr. Joel Kaufman**, University of Washington
- **Dr. Patrick Kinney**, Boston University School of Public Health
- **Dr. Michael T. Kleinman**, University of California at Irvine
- **Dr. Rob McConnell**, University of Southern California
- **Mr. Richard Poirot**, Independent Consultant
- **Dr. Lianne Sheppard**, University of Washington
- **Dr. Jeremy Sarnat**, Rollins School of Public Health, Emory University
- **Dr. Barbara Turpin**, University of North Carolina at Chapel Hill
- **Dr. Ronald Wyzga**, Retired, Electric Power Research Institute

C125

Independent Particulate Matter Review Panel

- Followed the same process and procedures as we did formerly as the CASAC PM Review Panel
- Developed a letter to the EPA Administrator and Consensus Responses to EPA Charge Questions on the Draft Policy Assessment
- Submitted our report to CASAC, the docket, and the Administrator
- **ucsusa.org/pmpanel**

C126

Acknowledgment of EPA Staff

- The Panel finds that the EPA staff in the Office of Air Quality Planning and Standards have undertaken a good faith effort to produce a first draft of the PA.
- This draft was produced under extenuating, unprecedented, and inappropriate constraints.
- **The Panel commends the staff for this effort.**

C127

Causality Determinations

- The **weight of evidence framework for causality determination** that is applied by EPA **is an appropriate and well-vetted tool** for drawing causal conclusions.
- The epidemiologic **evidence**, supported by evidence from controlled human studies and toxicological studies, **supports the 'causal' and 'likely to be causal' determinations** that are the focus of the draft PA.
- "The epidemiologic **evidence** provides strong scientific **support for recommendations** regarding current and alternative standard levels."
- **Arguments to retain the current primary $PM_{2.5}$ standards** "would require disregard of the epidemiological evidence," and "are not scientifically justified and **are specious**."

C128

Major Findings: Fine Particle Standards

- The current primary fine particle ($PM_{2.5}$) annual and 24-hour standards are **not protective of public health**.
- Retain current indicators, averaging times, and forms.
- The **annual** standard should **be 10 $\mu g/m^3$ to 8 $\mu g/m^3$** (versus 12 $\mu g/m^3$ now).
- The **24-hour** standard should be **30 $\mu g/m^3$ to 25 $\mu g/m^3$** (versus 35 $\mu g/m^3$ now).
- **Consistent epidemiological evidence** from multiple multi-city studies, **augmented with** evidence from **single-city studies**, at policy-relevant **ambient concentrations** in areas with design values at and **below the levels of the current standards.**
- **Supported** by research from **experimental models** in animals and humans and by **accountability studies**

Major Findings: Fine Particle Standards

- A motivation for strengthening the 24-hour $PM_{2.5}$ standard is high 24-hour to annual ratios related to **residential wood combustion** in some areas.
- Panel notes **growing frequency and severity of so-called "wildfires."**

C130

Accounting for Limitations

- The Panel considered in detail uncertainties and limitations of available epidemiologic evidence, such as:
  - Use of linear, multipollutant models
  - Possibility that co-pollutants may be effect modifiers rather than confounders
  - Confounding by individual characteristics has been considered and evaluated
  - No rationale or empirical support for confounding by temperature in annual studies
- Consistency among **multiple multicity models**, for which there is variability in relative ambient **mixtures of co-pollutants**, **population demographics**, **climatic zones**, and distributions of **housing characteristics**, supports the **robustness** of their results.

C131

Recommended Range for Annual $PM_{2.5}$ Standard

- At **10 μg/m³** there is a **very high degree of scientific confidence** in the relationship between exposure to fine particles and **adverse effects**.
- The risk is **linear** with **no threshold** below the current standard down to an annual level of 8 μg/m³ or lower.
- The Panel finds that there is **not sufficient scientific certainty below 8 μg/m³ to support a lower recommendation.**

C132

Other Issues: At Risk Groups

- Di et al. (2017a) chronic Medicare study shows that the relative risk for African Americans is three times higher than that of the entire population (hazard ratio of 1.21 per 10 μg/m^3 increase in $PM_{2.5}$).

C133

BAAQMD's Questions

- Are current PM standards sufficiently protective? **Emphatic <u>NO</u> – definitely not for $PM_{2.5}$.**
- How has the PM health evidence been strengthened? **Better "exposure" models, much larger study populations at much lower levels than before.**
- What new health effects are now recognized? **Strengthening of some causality determinations, but largely the focus is still premature mortality, respiratory morbidity, and cardiovascular morbidity.**
- New endpoints like cancer and central nervous system effects? **Opinions differ.**
- New sensitive groups, like children and lower socioeconomic status, SES, populations? **Growing recognition of "at risk" groups.**
- Are all types of PM equal? **Probably not.** Or, are some more dangerous than others? **Probably. But, more work needed. No components are as yet 'exonerated.'**
- How severe are PM health risks? **Premature mortality is severe.**
- What additional health benefits can be achieved by further reducing PM to below current standards? **Difficult to quantify with certainty but on the order of tens of thousands of deaths nationally.**

C134

BAAQMD’s Questions

- How important are short-term PM events, like wildfires? **Not well-known scientifically but of concern for potential or anticipated effects**. **Research recommended.**
- How should we weight them in comparison with ongoing day-to-day PM levels? **No simple answer. Depends… can they be controlled? If so, how? Via a state implementation plan? And would you slap non-attainment on an area just devastated by a wildfire?**
- How important are ultrafine particles, UFPs? **Current evidence of adverse effects is generally weak but there is concern for potential or anticipated effects. Need more monitoring to support more epidemiological studies**. **Panel recommends a UFP FRM for this purpose.**
- Should we consider more than just PM mass? *(meaning particle number concentration?)* **In research, absolutely. In regulation, too soon, unless one takes a very precautionary, highly risk-averse decision approach.**
- Which is most protective, an annual average target or a 24-hour average one? Or, a sub-daily average? **For most parts of the country, annual can offer protection also for 24-hour averages. For other parts, not so. Panel comments on this. Health data on sub-daily is too limited as yet to support a standard at the national level, but Panel has recommendations to look at this further**.

C135

Next Steps

- CASAC will release its draft report on the draft PM Policy Assessment within a few weeks.
- CASAC will meet on December 3, 2019 to review and likely finalize its report to the Administrator
- Opportunity for public comment in writing beforehand and oral comment at the meeting.
- *CASAC will review the draft ISA and draft PA for <u>Ozone</u> at the Dec 3-6, 2019 meeting*.

Key Points

- The NAAQS Science Review Process Worked Well Until 2017
- EPA Administrators Pruitt and Wheeler Have Broken the Process
- Particulate Matter Science Review By CASAC is Highly Deficient: Appropriate to Look Elsewhere
- Disbanded CASAC PM Review Panel Reconvened Itself
- Key Findings of the Independent Particulate Matter Review Panel

Acknowledgments

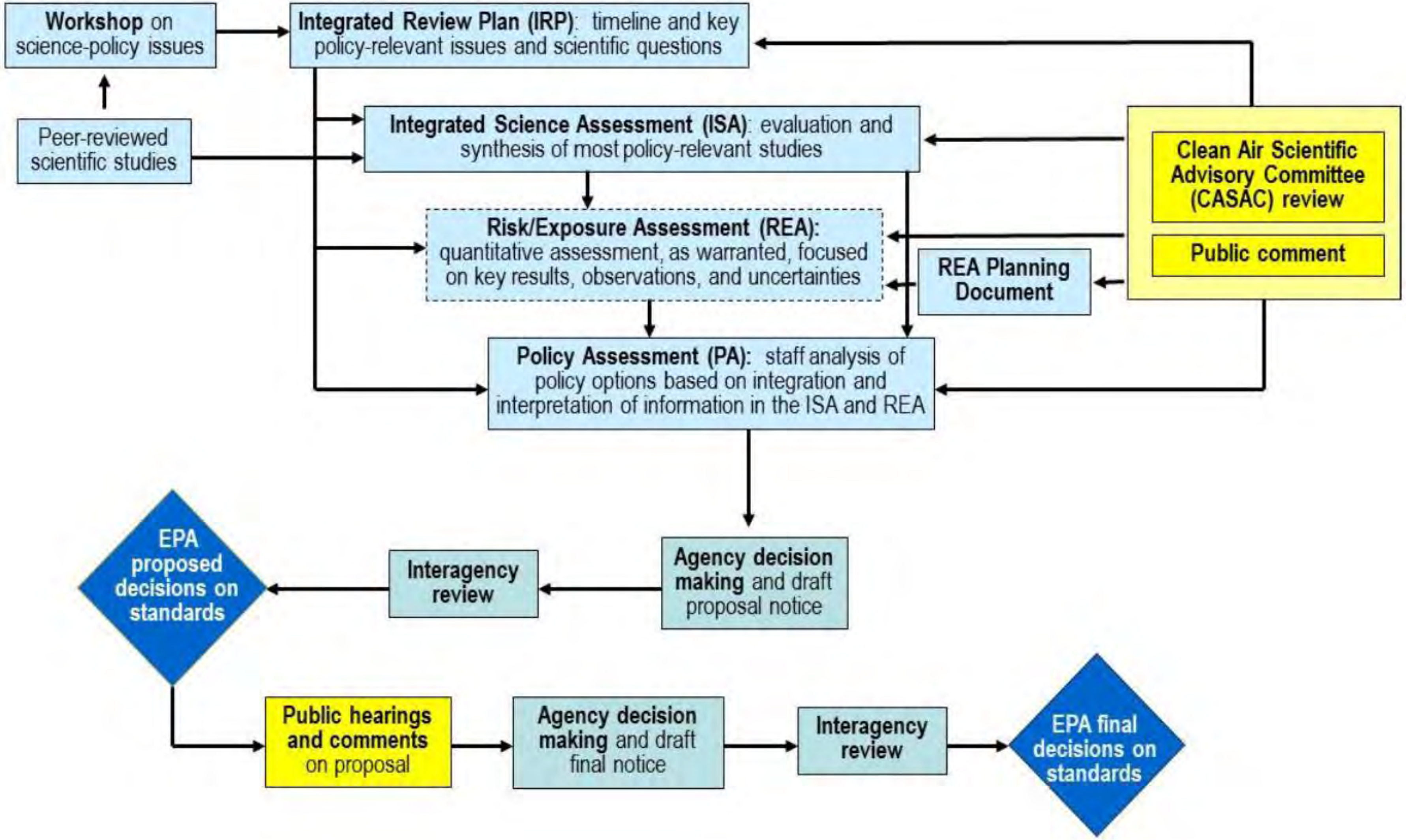
- Members of the Independent Particulate Matter Review Panel.
- Union of Concerned Scientists hosted the October 2019 meetings of the Panel. Special thank you to Dr. Gretchen Goldman.
- Mr. Chris Zarba acted in the role of a designated officer for the panel.
- Mr. John Bachmann and Mr. Steven Silverman provided technical and legal clarifications, respectively.
- This presentation has not been reviewed or approved by anyone. The author is solely responsible for its content.

frey@ncsu.edu

Report of the Independent Particulate Matter Review Panel is at:

ucsusa.org/pmpanel

Overview of EPA's Process for Reviewing National Ambient Air Quality Standards, 2016



C140

Generic "Full" NAAQS Science Review from CASAC and Public Perspective

CASAC Meeting*	Topic
1 & 2	Draft Integrated Review Plan
3 & 4	1st Draft Integrated Science Assessment
	Risk & Exposure Assessment Plan
5 & 6	2nd Draft Integrated Science Assessment
	1st Draft Risk & Exposure Assessments
7 & 8	2nd Draft Risk & Exposure Assessments
	1st Draft Policy Assessment
9 & 10	2nd Draft Policy Assessment

*Meetings 1, 2, 4, 6, 8, 10 by teleconference; Meetings 3, 5, 7, 9 face-to-face
Public Comment at EVERY meeting (10 opportunities)

C141

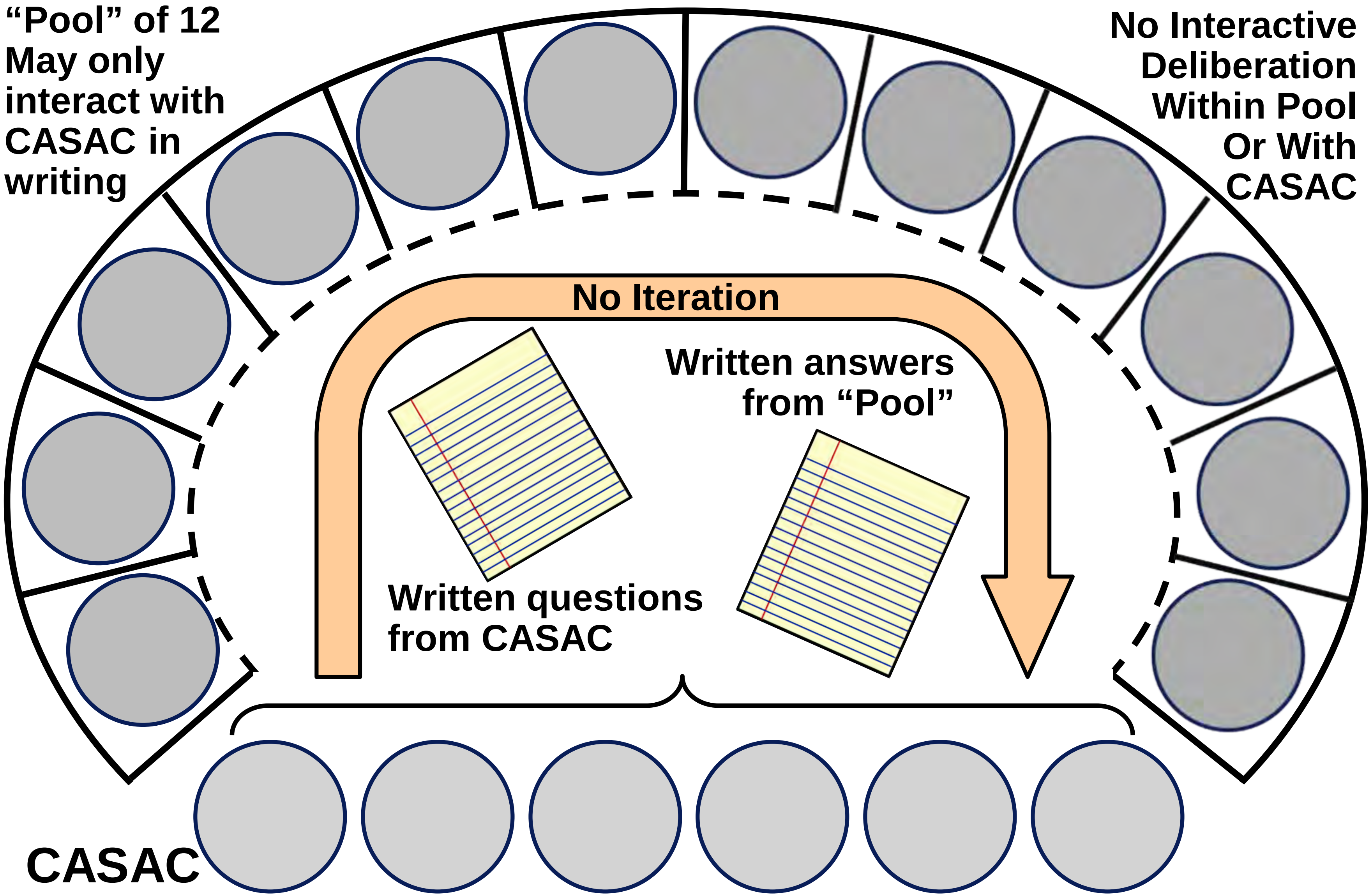
Pruitt/Wheeler (P/W) Particulate Matter NAAQS Science Review from CASAC and Public Perspective

CASAC Meeting*	Topic	
1 & 2	Draft Integrated Review Plan	*2016 Before P/W*
3 & 4	1st Draft Integrated Science Assessment	
	[redacted]	
[redacted]	[redacted]	
5 & 6	[redacted]	
	1st Draft Policy Assessment	
[redacted]	[redacted]	

*Meetings 1, 2, 4, 6 by teleconference; Meetings 3, 5 face-to-face
Public Comment at EVERY meeting (6 opportunities) [Only 4 in P/W era]

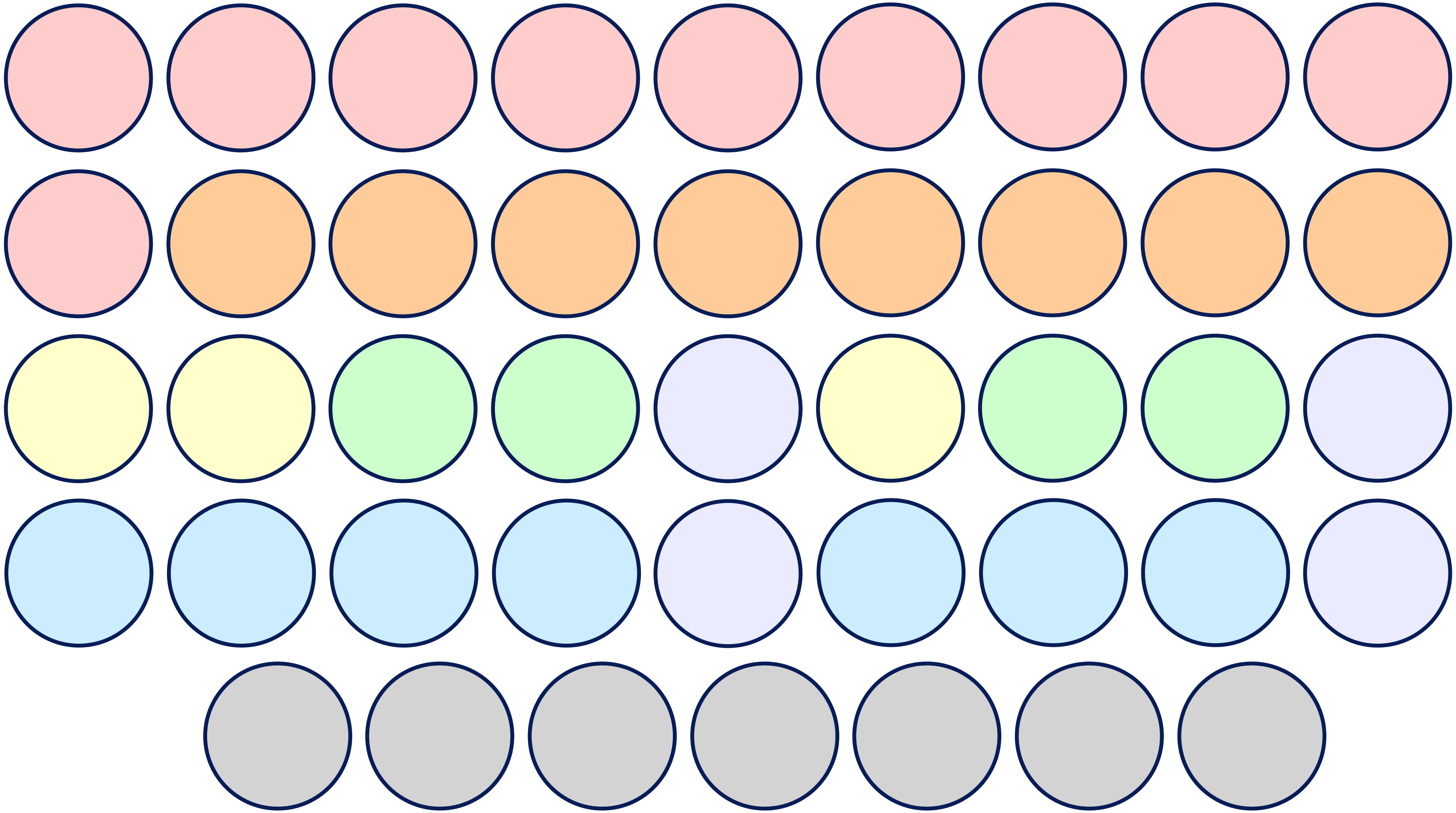
C142

Wheeler Ad Hoc “Pool” of External Consultants for PM and O_3 Reviews



C143

Typical Pre-Pruitt/Wheeler CASAC for PM and O_3 Reviews: CASAC Augmented with PM and O3 Panels



C144

Report of the Independent Particulate Matter Review Panel

- ucsusa.org/pmpanel
- 11 page letter (5 pages of text)
- Attachment A: Panel Roster (2 pages)
- Attachment B: Consensus Responses (43 pages)
- Attachment C: Individual Member Comments (117 pages)
- Attachment D: History, Membership Criteria, and Administrative Procedures of the Panel
- Attachment E: Panel Member Biosketches

C145

Major Findings: Coarse PM

- Coarse PM (PM_{10} as an indicator for $PM_{10-2.5}$)
  - Retain current indicator, form, and averaging time (24-hour)
  - Current level of protection should at least be maintained
  - Need to revise downward with downward revision of 24-hour $PM_{2.5}$ standard.
  - Should move to $PM_{10-2.5}$ as the indicator in the next review.

Major Findings: Visibility

- Welfare (Secondary) Standards
  - Current annual standard has no effect (15 $\mu g/m^3$ vs. 12 $\mu g/m^3$ for primary $PM_{2.5}$ standard.
  - Annual should at least match primary annual.
  - 24-hour standard is not adequate to protect against visibility effects
  - A second draft of the PA should identify and analyze alternatives
  - Panel offers recommendations regarding alternative indicators, averaging times, forms, and levels to be considered.

C147

Process Issues (Overview, Examples)

- Since 2017, the Panel finds that the EPA has made unwarranted changes to the CASAC and the NAAQS review process.
- Detailed recommendations to reverse the unwarranted changes are in the consensus responses.
- A second draft of the ISA should be reviewed by CASAC and the public, and the ISA should be finalized, prior to release of a second external review draft of the PA
- The CASAC PM Review Panel should be reappointed to provide CASAC with the expertise it needs.

New Federal Reference Methods Needed

- The Panel recommends that Federal Reference Methods be developed for Ultrafine Particles and Black Carbon
- FRMs for UFP and BC should be deployed to collect data need for health studies and for baselines

Particulate Matter:
Spotlight on Health Protection

Break




Advisory Council Discussion with Health Effects Panel

Discussion Questions

Are current PM standards sufficiently health protective?

Are some species of PM more dangerous than others?

What is role of ultrafine particles (UFPs)?

How should air quality targets be set? Should form of target expand to account for more than just mass?

How should we include draft PM ISA's new "likely-causal" health endpoints (nervous system effects, cancer) and new more sensitive populations (children, lower socio-economic status)?

What are health impacts of high-concentration acute events (e.g., wildfires)? How should we compare them to day-to-day PM impacts?

Lunch

Keynote – Gina McCarthy

Particulate Matter:
Spotlight on Health Protection

Particulate Matter:
Spotlight on Health Protection

Bay Area Air Quality Management District

C154

Gina McCarthy

- Former EPA Administrator
- Finalized the Clean Power Plan and the Clean Water Rule
- Professor of the Practice of Public Health in the Department of Environmental Health at Harvard T.H. Chan School of Public Health
- Director of the Center for Climate, Health, and the Global Environmental
- Member of the Board of Directors of the Energy Foundation and Ceres
- M.Sc. in Environmental Health Engineering, Planning and Policy from Tuft's University

Particulate Matter:
Spotlight on Health Protection




Exposure and Risk

Lauren Zeise, Ph.D.

- Appointed by Gov. Brown as Director of the California Office of Environmental Health Hazard Assessment in December 2016
- Former Chief of the cancer unit at the California Department of Health Services
- Leading role in OEHHA's development of CalEnviroScreen
- Co-led the team that developed the hazard trait regulation for California's Safer Consumer Products program
- Member, fellow, former editor, and former councilor of the Society for Risk Analysis
- 2008 recipient of the Society's Outstanding Risk Practitioner Award
- Ph.D. from Harvard University

Exposure and Risk Panel

Particulate Matter: Spotlight on Health

Bay Area Air Quality Management District

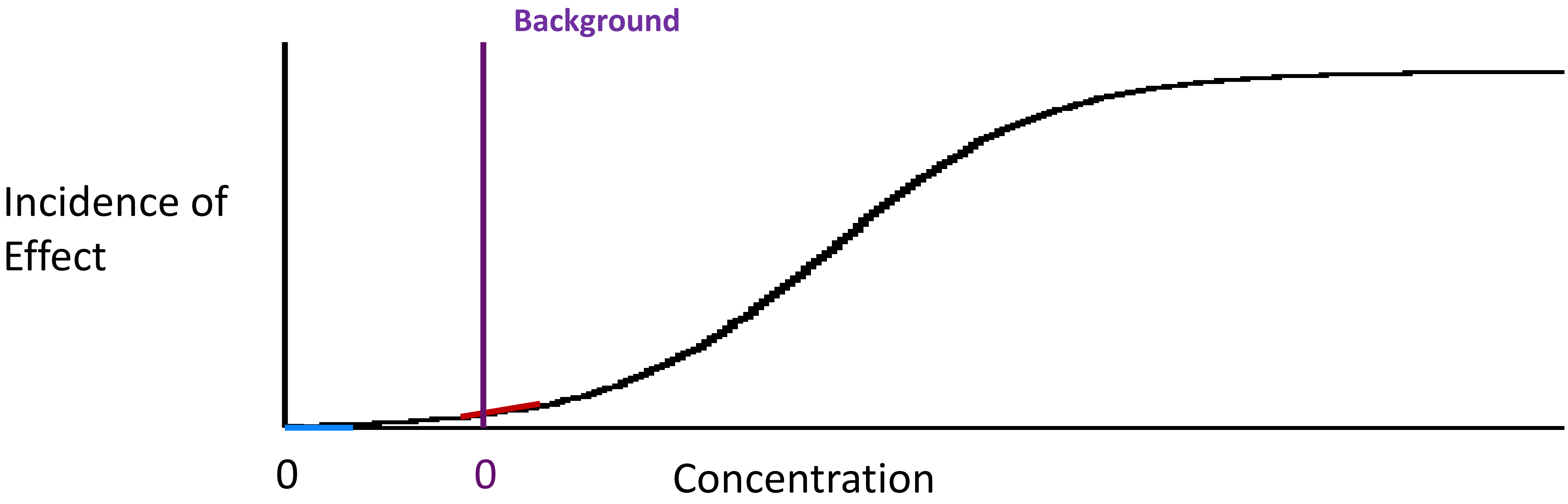
October 28, 2019

Lauren Zeise

California Environmental Protection Agency

Office of Environmental Health Hazard Assessment

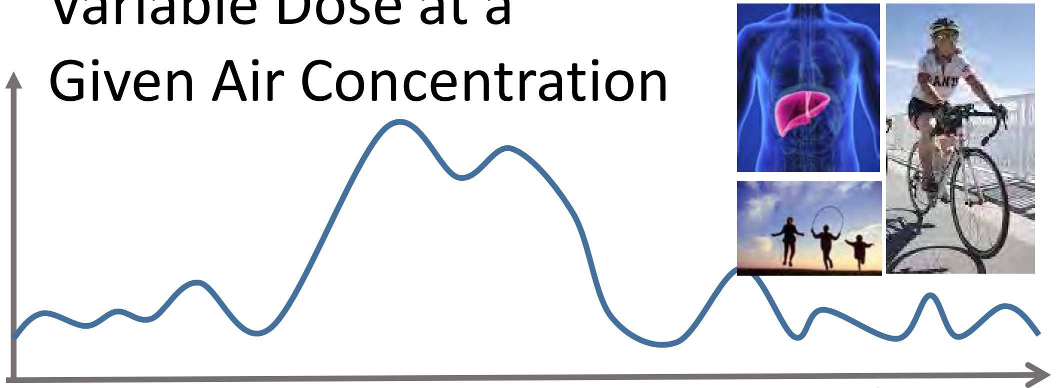
Population Concentration-Response Relationships



Variability Underlying Concentration Response Observations

Variable Dose at a Given Air Concentration

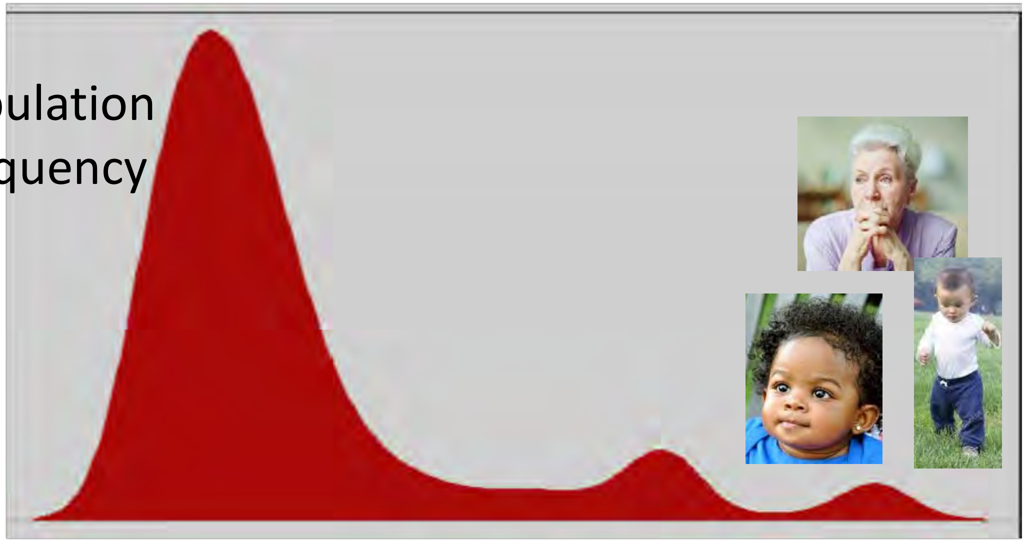
Population Frequency



Increasing Dose

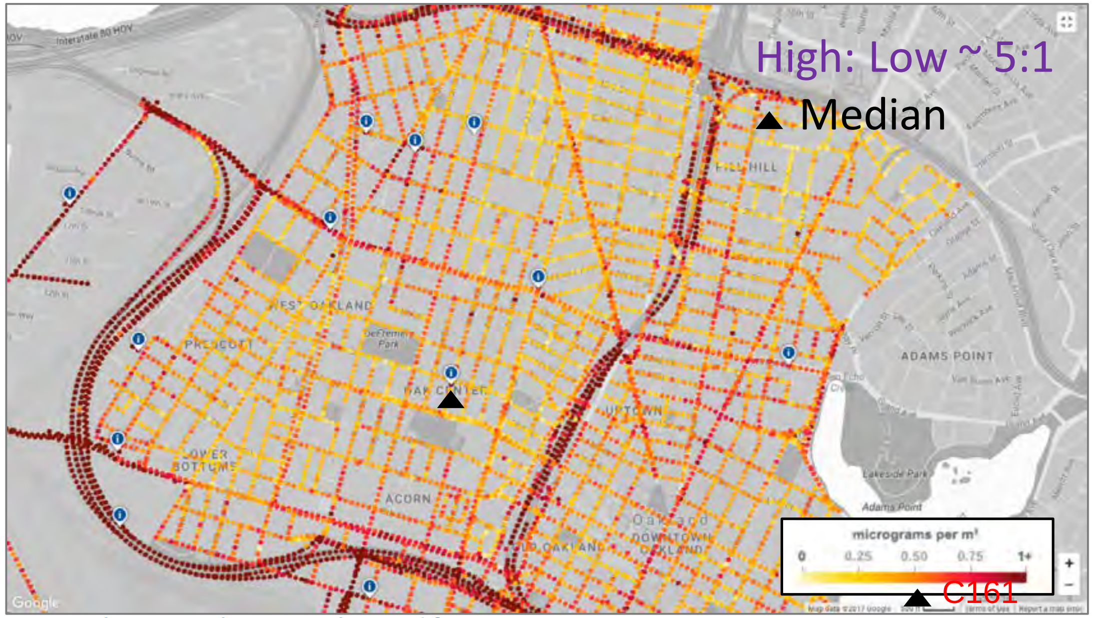
Variable Risk at a Given Dose

Population Frequency

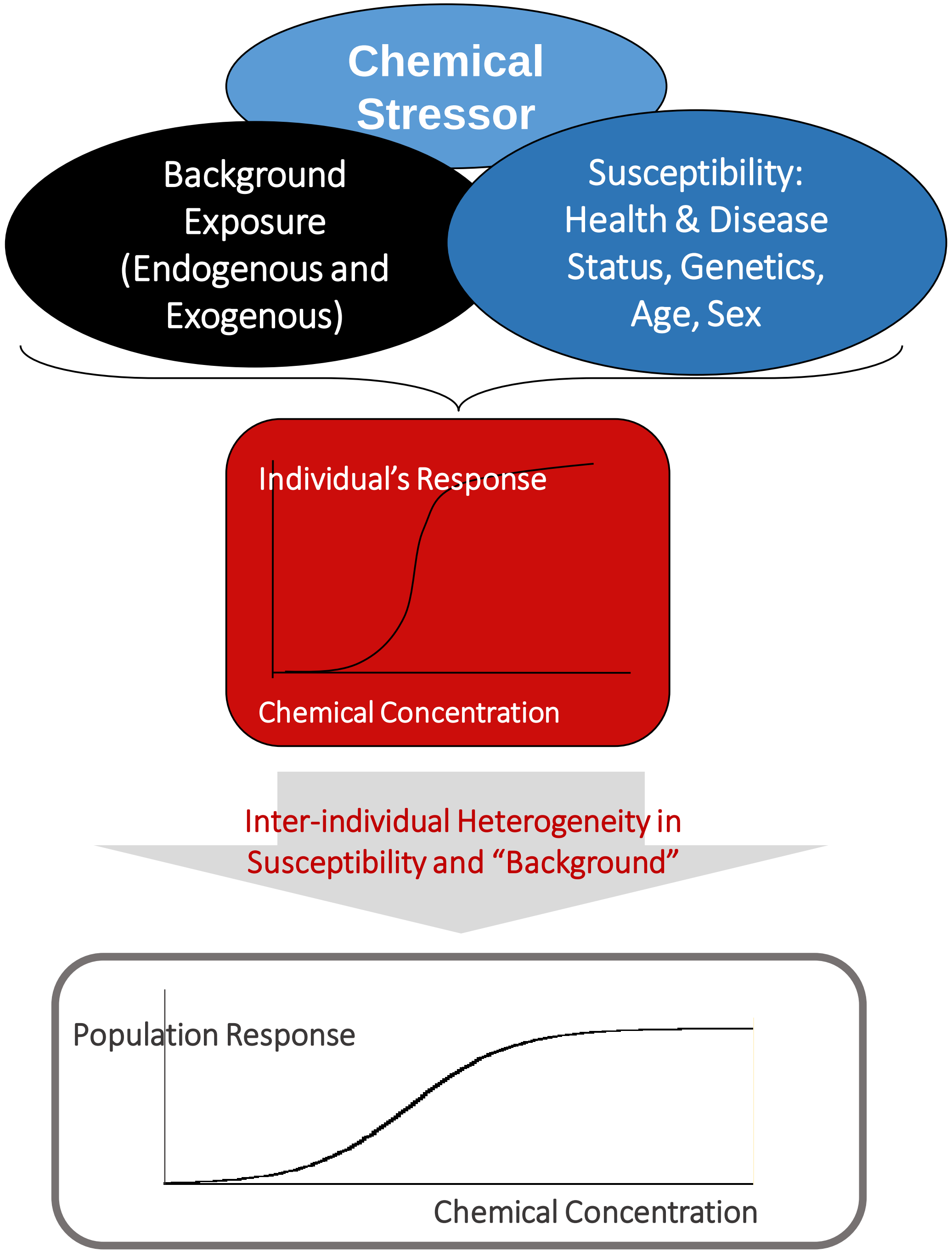


Increasing Risk

Variable Concentration with Location



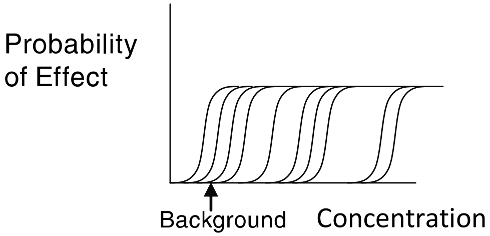
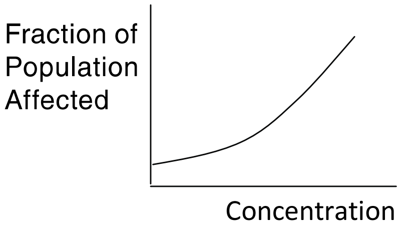
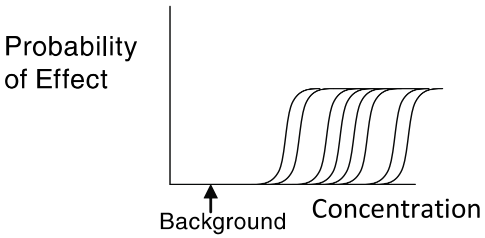
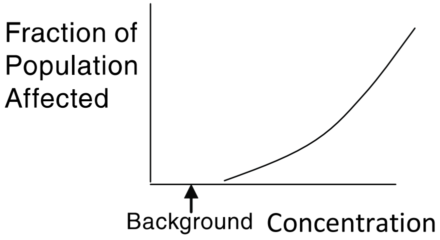
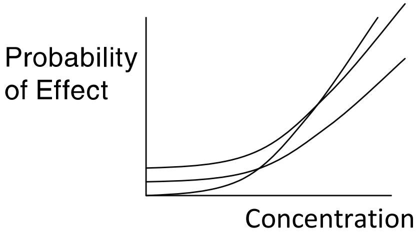
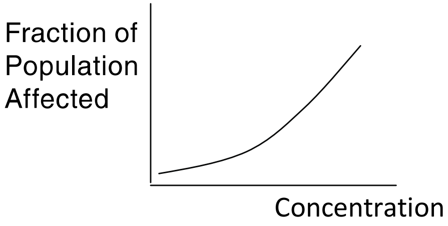
Sarah Vogel svogel@edf.org



Considerations for Interventions

- Risk determined by individual's biologic make-up, health status, endogenous and exogenous exposures that affect toxic chemical process
- Differences among people in these factors affect the shape of the concentration response curve

Individual vs Population Concentration-Response

	Individual level	Population Level
1. An individual's: Nonlinear The population: Linear		
2. An individual's: Nonlinear The population: Nonlinear		
3. An individual's: Linear The population: Linear		

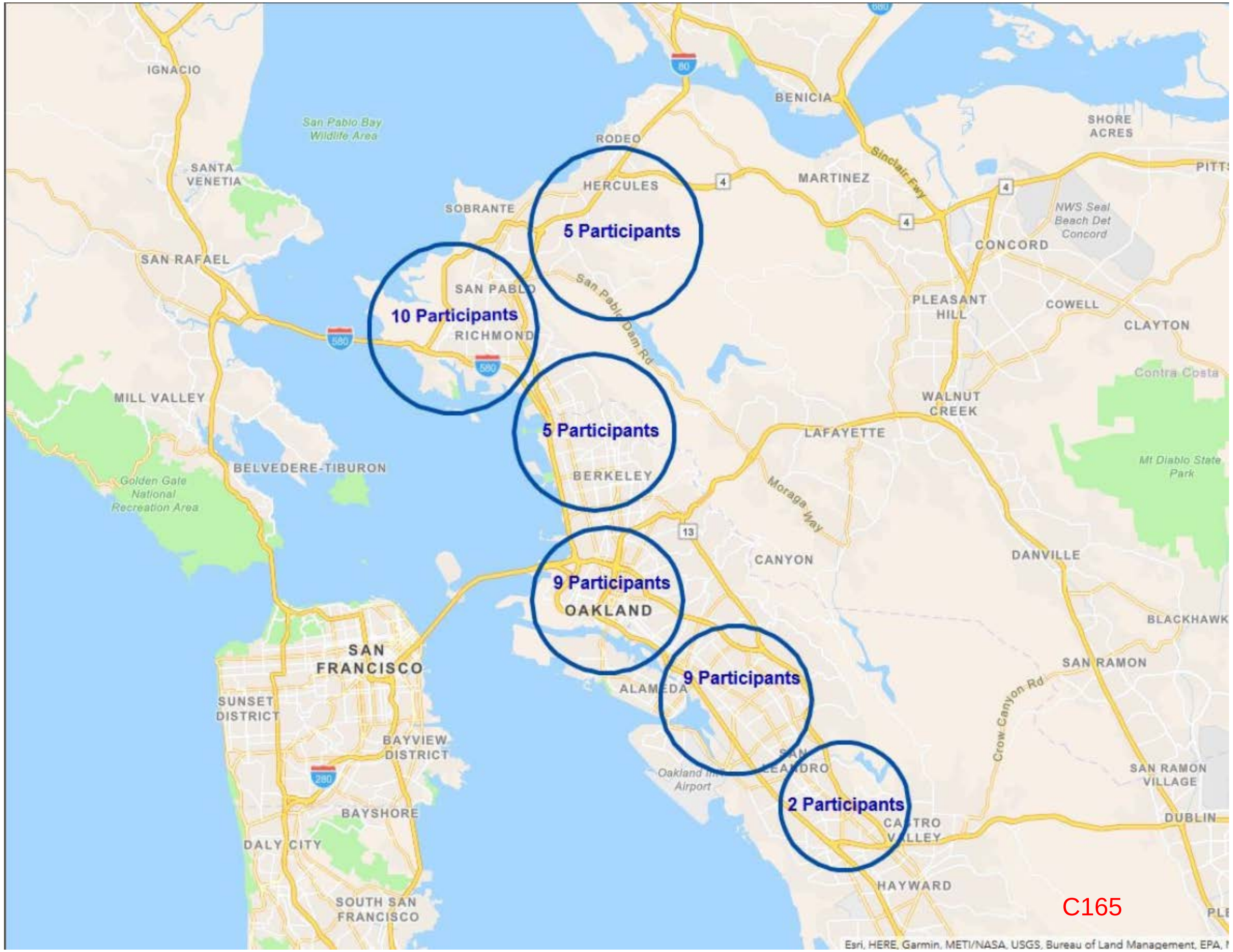
East Bay Diesel Exposure Project

- Measure exposures to diesel exhaust in East Bay community residents
  - ➢ Biomonitoring – urine (1-Nitropyrene metabolites)
  - ➢ Dust in home
  - ➢ Indoor Air (1-Nitropyrene, Black carbon with real-time sensor)
- Measure in child-parent pairs to evaluate exposure patterns within family and across ages
- Collect urine & air samples at two time points to look at seasonal differences
  - ➢ 25 families: one urine sample at end of 4 day periods
  - ➢ 15 families: daily urine samples x 4 days
- Collect information related to sources and activities
  - ➢ Exposure questionnaire
  - ➢ GPS data loggers – every 5 minutes
  - ➢ Activity diaries

C164

EBDEP Participant Locations

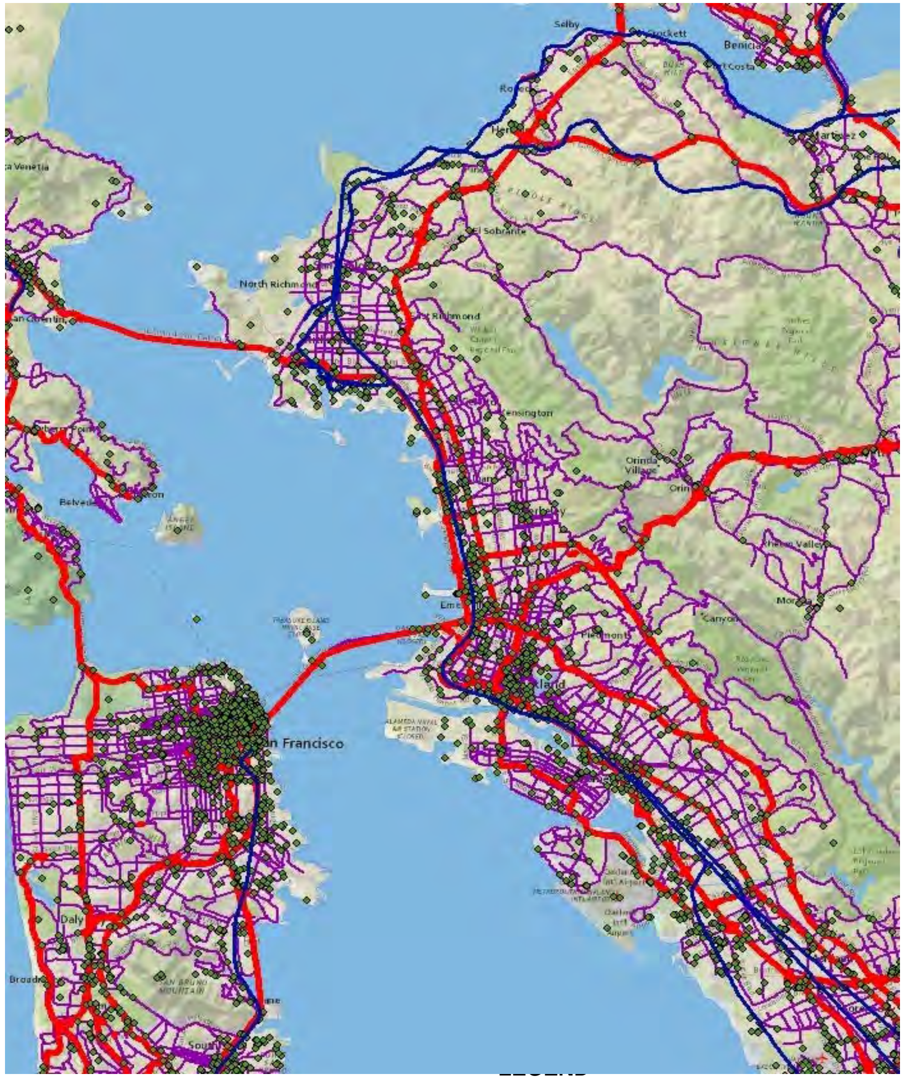
- East Bay
- Neighborhoods with a range of diesel exhaust exposure, based on:
  - ➢ CalEnviroScreen's diesel particulate matter indicator (based on CARB data)
  - ➢ Diesel truck traffic patterns
  - ➢ Local air pollution mapping



C165

GIS Diesel Source Layers and Maps

- Permitted stationary emission sources (BAAQMD)
- Railway lines and railway road crossings
- Caltrans Truck Network
- Caltrans Bottlenecks (highway congestion)
- AC Transit and Amtrak bus routes and stops
- Major roads
- Industrial land use zoning maps (county)
- Highway Performance Monitoring System traffic data
- California ports



Complementary Pilot Air Quality Study

- Measure ambient air concentrations of black carbon and selected PAHs in areas of Richmond relevant to EBDEP
- Conduct field sampling for several days during periods of moderate and high pollution
- Analyze results to:
  - Compare levels across location and time
  - Examine patterns for possible clues on sources

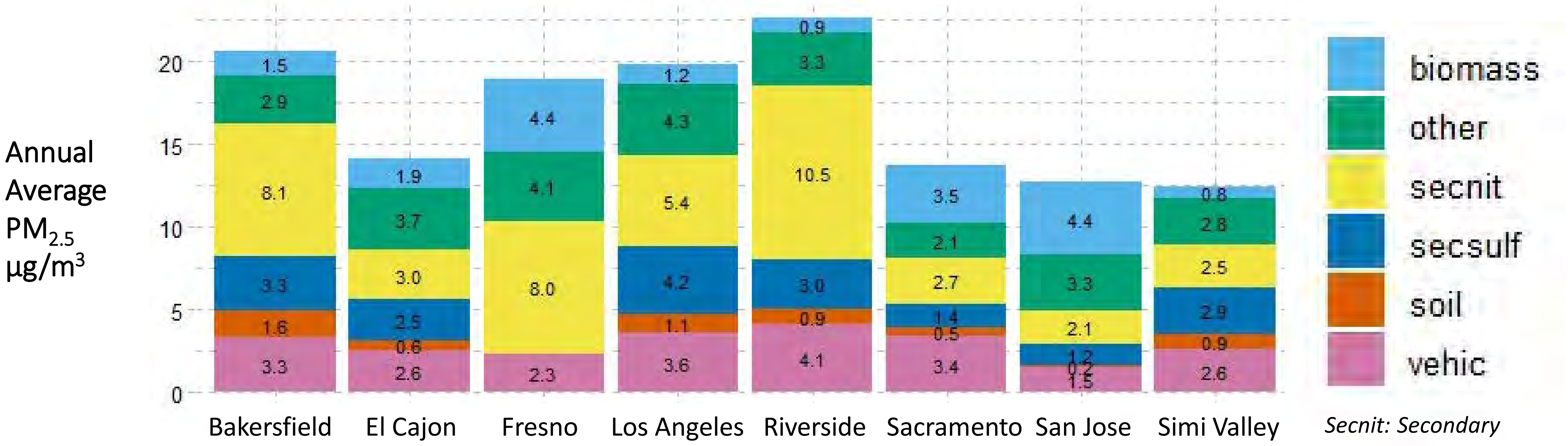
Berkeley
UNIVERSITY OF CALIFORNIA

Principal Investigator: Betsey Noth, UC Berkeley
OEHHA funded

OEHHA Biomonitoring to Support AB 617

- Directly measure exposure to a chemical(s) of concern
- Establish baseline exposures prior to reduction efforts
- Examine exposures associated with a specific source(s) in the community, and/or
- Evaluate the effectiveness of exposure reduction efforts

Estimated $PM_{2.5}$ Source Contribution by Monitoring Site



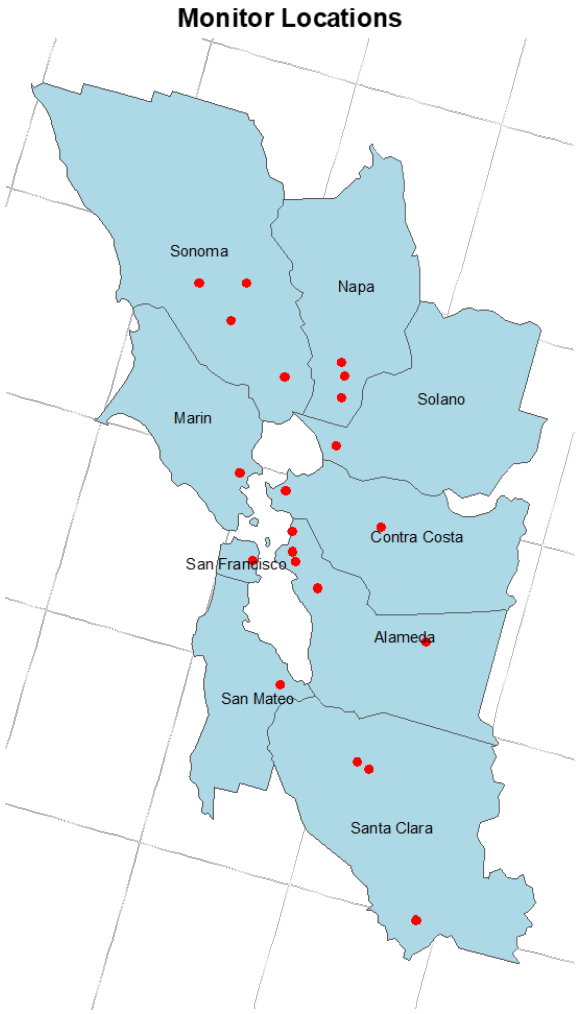
Secnit: Secondary Ammonium Nitrate
Secsulf: Secondary Ammonium Sulfate

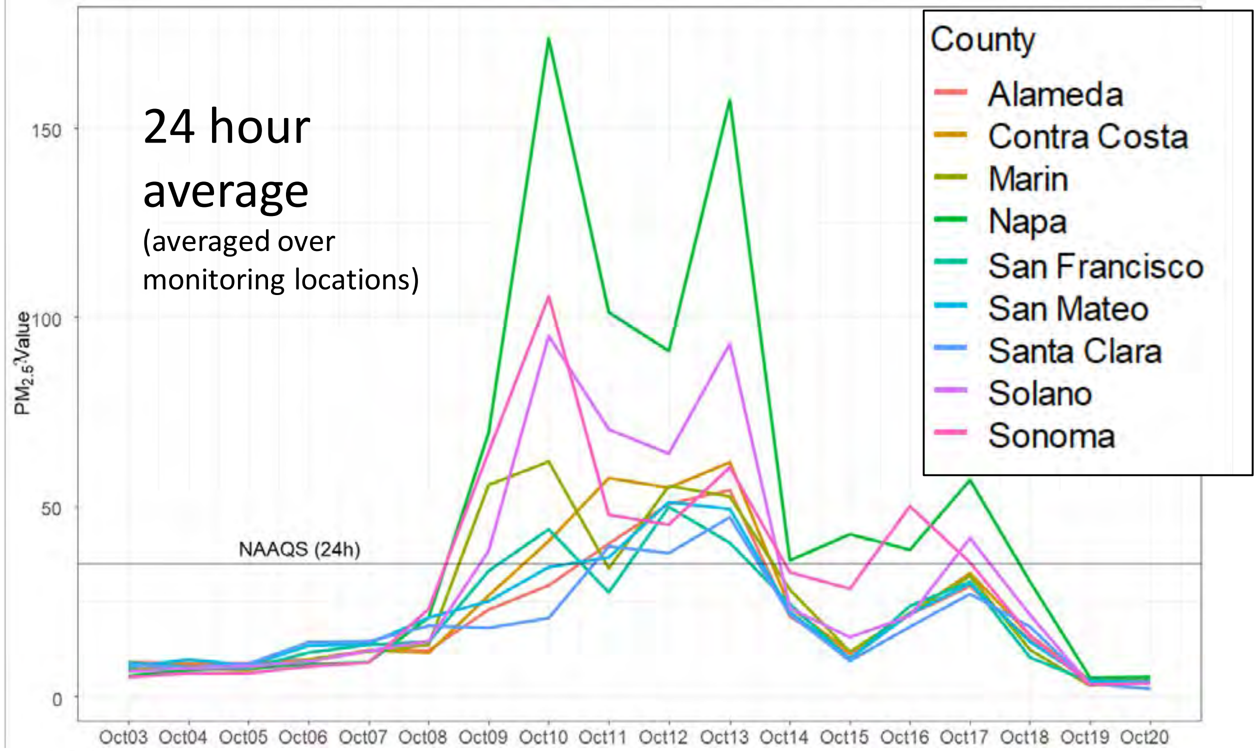
Source	Marker Constituents
Biomass	EC, OC, K
Secondary Ammonium Nitrate	NO_3^-, NH_4^+
Secondary Ammonium Sulfate	$SO_4^=$, NH_4^+
Resuspended Soil	Al, Si, Ca, Fe, Ti
Vehicular Emissions	EC, OC, Fe, Cu, Zn

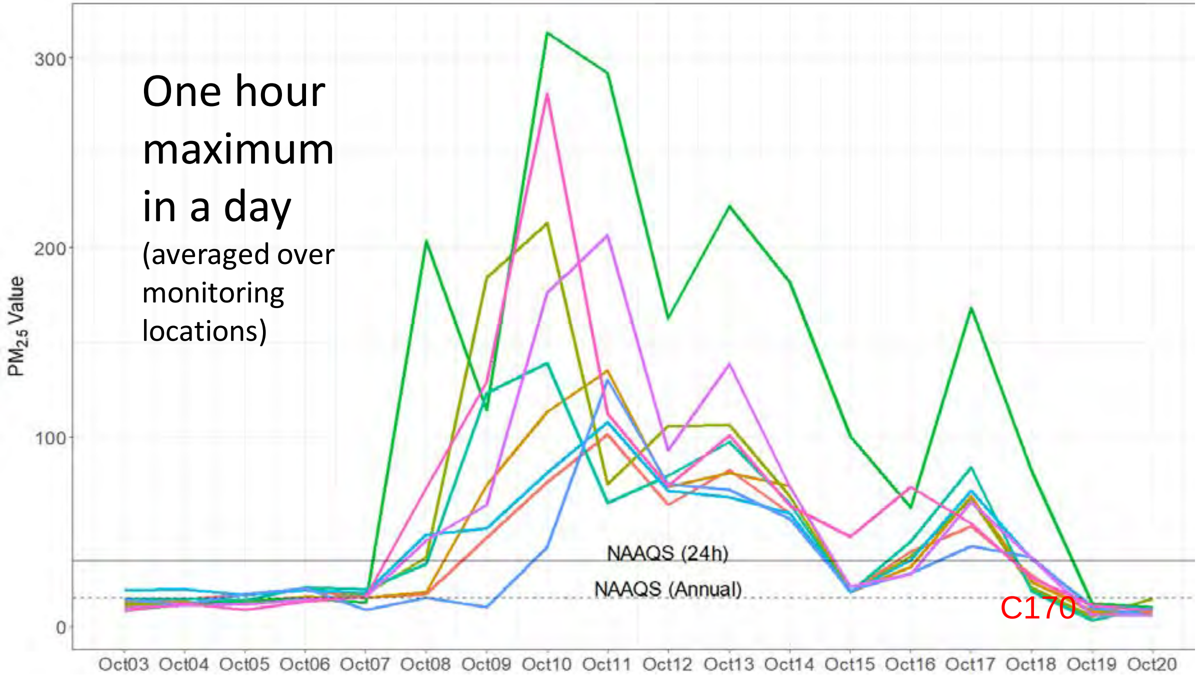
$PM_{2.5}$ in Bay Area During 2017 Napa Wildfire

Health Outcomes Being Investigated

- Cardiovascular Disease
- Ischemic Heart Disease
- Acute Myocardial Infarction
- Dysrhythmia
- Cerebrovascular Disease
- Transient Ischemic Attack
- Peripheral Vascular Disease
- Diabetes
- Respiratory Disease
- Asthma/Wheeze
- Pneumonia
- Chronic Lower Respiratory Disease
- Acute Upper Respiratory Infection
- Mental/Behavioral Disorders

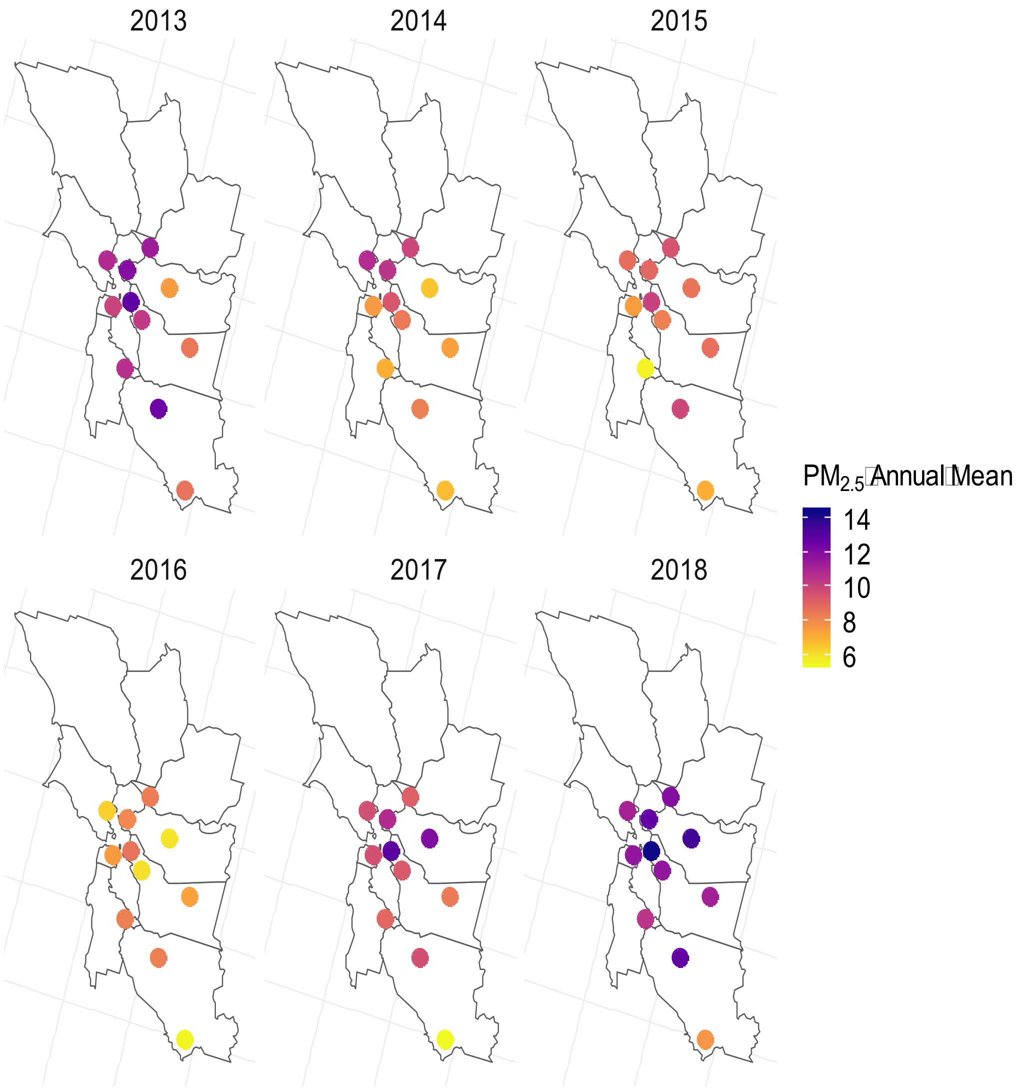




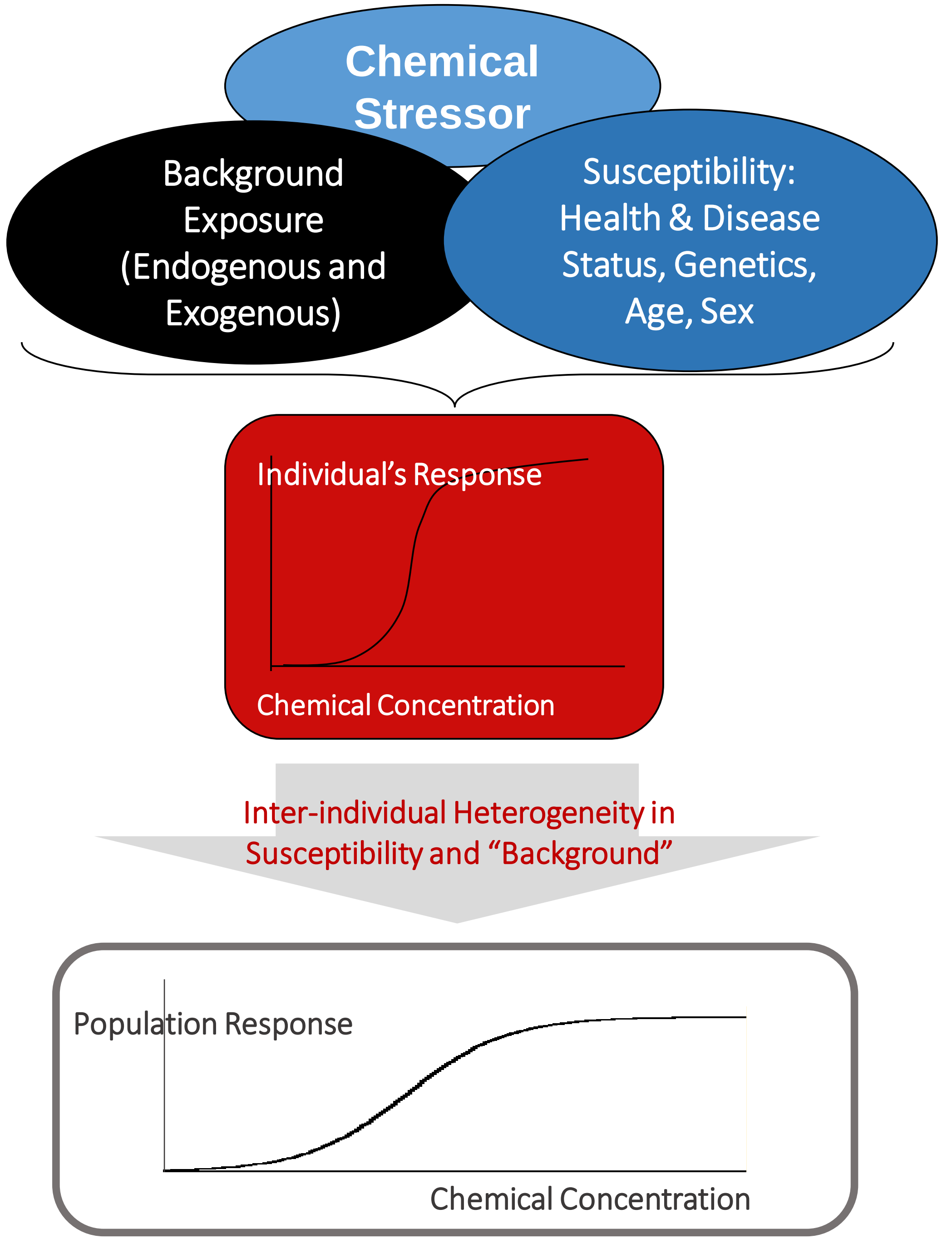


C170

Wildfire Affects Annual Average of $PM_{2.5}$



- Wildfire PM adds to underlying "baseline"
- Monitor in West Oakland:
  - 2017: 12.9 µg/m^3
  - 2018: 14.4 µg/m^3


Chemical Stressor
Background Exposure (Endogenous and Exogenous)
Susceptibility: Health & Disease Status, Genetics, Age, Sex
Individual's Response
Chemical Concentration
Inter-individual Heterogeneity in Susceptibility and "Background"
Population Response
Chemical Concentration

C172

Acknowledgements

- OEHHA Community Health and Environmental Impacts Section: Rupa Basu, Keita Ebisu, et al.
- OEHHA Safer Alternatives Assessment and Biomonitoring Section: Sara Hoover, Russ Bartlett, Duyen Kauffman et al.

Particulate Matter:
Spotlight on Health Protection

Bay Area Air Quality Management District

C174

Julian Marshall, Ph.D.

- Kiely Endowed Professor of Environmental Engineering at University of Washington with a focus on air quality management
- Founded and runs the Grand Challenges Impact Lab, a UW study abroad program in Bangalore, India
- Associate Editor for Environmental Health Perspectives and Development Engineering
- Published over 100 peer-reviewed journal articles
- Ph.D. in Energy and Resources from UC Berkeley

Particulate Matter:
Spotlight on Health Protection

Scott Jenkins, Ph.D.

- Senior Environmental Health Scientist in EPA's Office of Air Quality Planning and Standards (OAQPS)
- Currently leading EPA’s review of the National Ambien Air Quality Standards (NAAQS) for Particulate Matter (PM)
- Howard Hughes Postdoctoral Research Fellow in the Department of Cell Biology at Duke University
- Ph.D. in Behavioral Neuroscience from the University of Alabama at Birmingham

REVIEW OF THE NATIONAL AMBIENT AIR QUALITY STANDARDS FOR PARTICULATE MATTER

OVERVIEW OF THE DRAFT POLICY ASSESSMENT

Scott Jenkins
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards

Presentation to the Bay Area Air Quality Management District

October 28, 2019

Outline of Presentation

- Overview of the standards, process and schedule
- Key information and analyses in draft Policy Assessment
- Preliminary conclusions on the primary $PM_{2.5}$ standards

C179

Current PM Standards Under Review

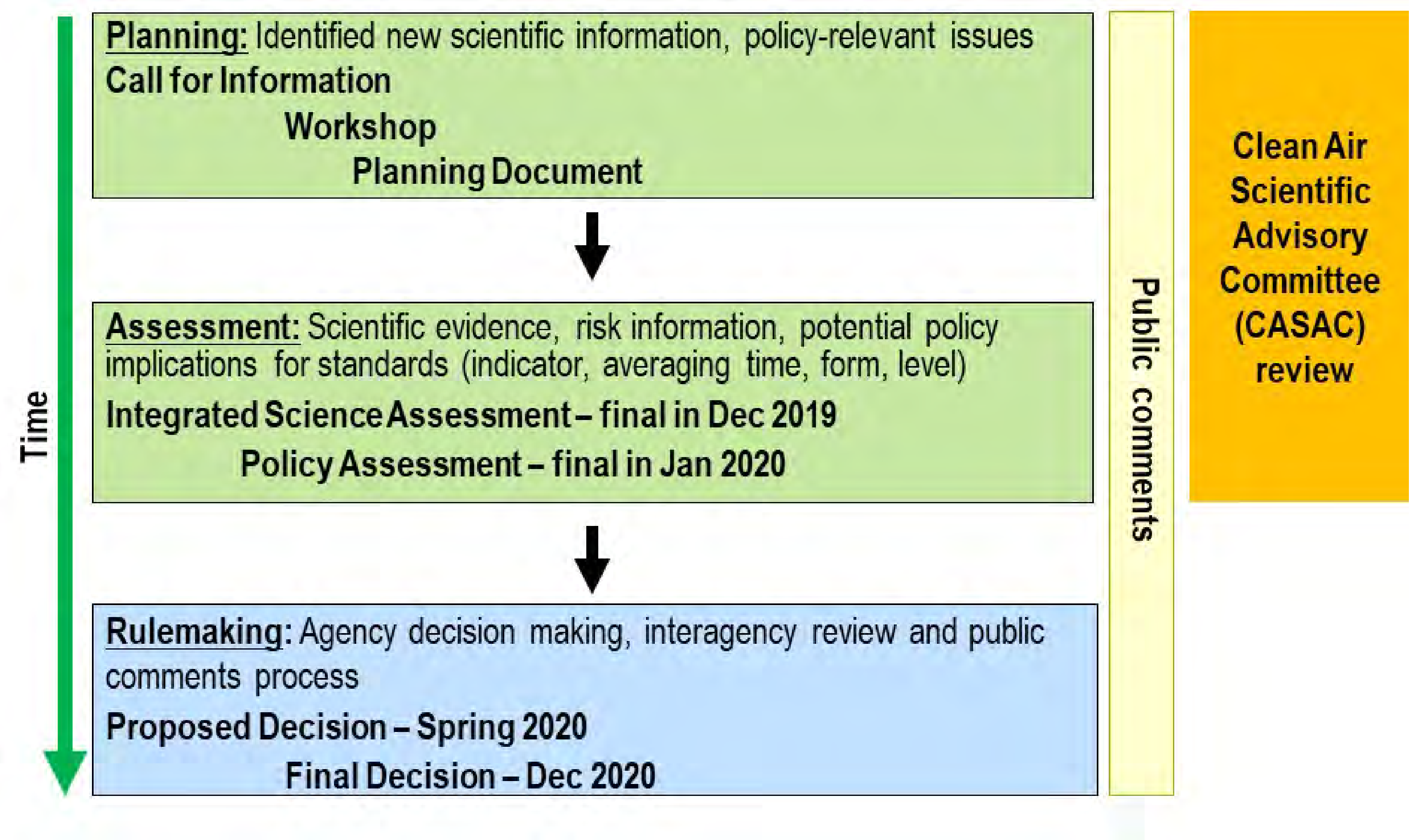
Current Standards – Last Review Completed in 2012*					Decisions in 2012 Review
Indicator	Averaging Time	Primary/Secondary	Level	Form	
$PM_{2.5}$	Annual	Primary	12.0 µg/m^3	Annual arithmetic mean, averaged over 3 years	Revised level from 15 to 12 µg/m^3**
		Secondary	15.0 µg/m^3		Retained**
	24-hour	Primary and Secondary	35 µg/m^3	98th percentile, averaged over 3 years	Retained
PM_{10}	24-hour	Primary and Secondary	150 µg/m^3	Not to be exceeded more than once per year on average over a 3-year period	Retained

*Prior to 2012, PM NAAQS were reviewed and revised several times – established in 1971 (total suspended particulate – TSP) and revised in 1987 (set PM_{10}), 1997 (set $PM_{2.5}$), 2006 (revised $PM_{2.5}$, PM_{10})

**EPA eliminated spatial averaging for the annual standards

C180

Process and Anticipated Schedule for This Review of the PM NAAQS



C181

Evaluating Primary $PM_{2.5}$ Standards: Summary of Approach

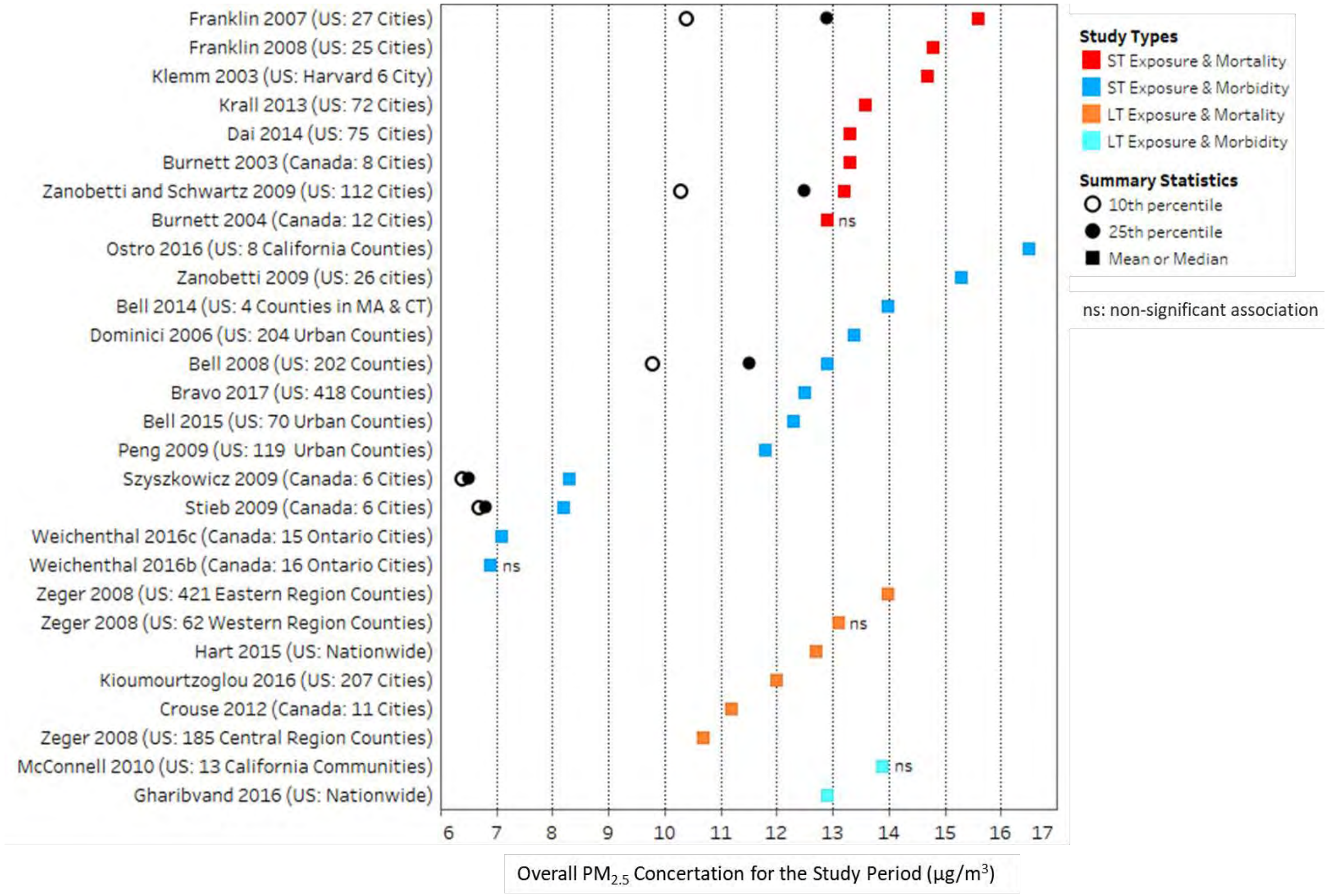
- The **annual** $PM_{2.5}$ **standard** is viewed as the principle means of providing public health protection against the bulk of the distribution of short- and long-term $PM_{2.5}$ exposures
- In previous reviews, conclusions on the annual $PM_{2.5}$ standard have been informed by consideration of the $PM_{2.5}$ air quality distributions associated with mortality or morbidity in epidemiologic studies
  - The current level of 12.0 $\mu g/m^3$ was set below the overall means of the long- and short-term $PM_{2.5}$ exposure estimates in key studies
- In this review, the draft PA characterizes those distributions by identifying overall means of $PM_{2.5}$ exposure estimates, concentrations corresponding to the lower quartiles of data (when available), and study-area metrics similar to design values (pseudo-design values)
- The **24-hour** $PM_{2.5}$ **standard**, with its 98th percentile form, is viewed as a means of providing protection against short-term exposures to peak $PM_{2.5}$ concentrations, such as can occur in areas with strong contributions from local or seasonal sources, even when mean $PM_{2.5}$ concentrations remain relatively low
- Controlled human exposure studies provide evidence for health effects following single, short-term $PM_{2.5}$ exposures to concentrations that typically correspond to upper end of the $PM_{2.5}$ air quality distribution in the U.S. (i.e., “peak” concentrations – see additional slides)

C182

$PM_{2.5}$ Concentrations in Epidemiologic Studies

- Overall mean concentrations reflect study averages of daily or annual $PM_{2.5}$ exposures – bulk of data generally occurs around overall means
- Key studies consistently reporting positive and statistically significant associations have overall mean $PM_{2.5}$ concentrations > 8.0 $\mu g/m^3$
- In studies with data available, 75% of health events occurred in areas with mean $PM_{2.5}$ concentrations ≥ 11.5 $\mu g/m^3$ (U.S. studies) or 6.5 $\mu g/m^3$ (Canadian studies)

Monitored $PM_{2.5}$ concentrations*



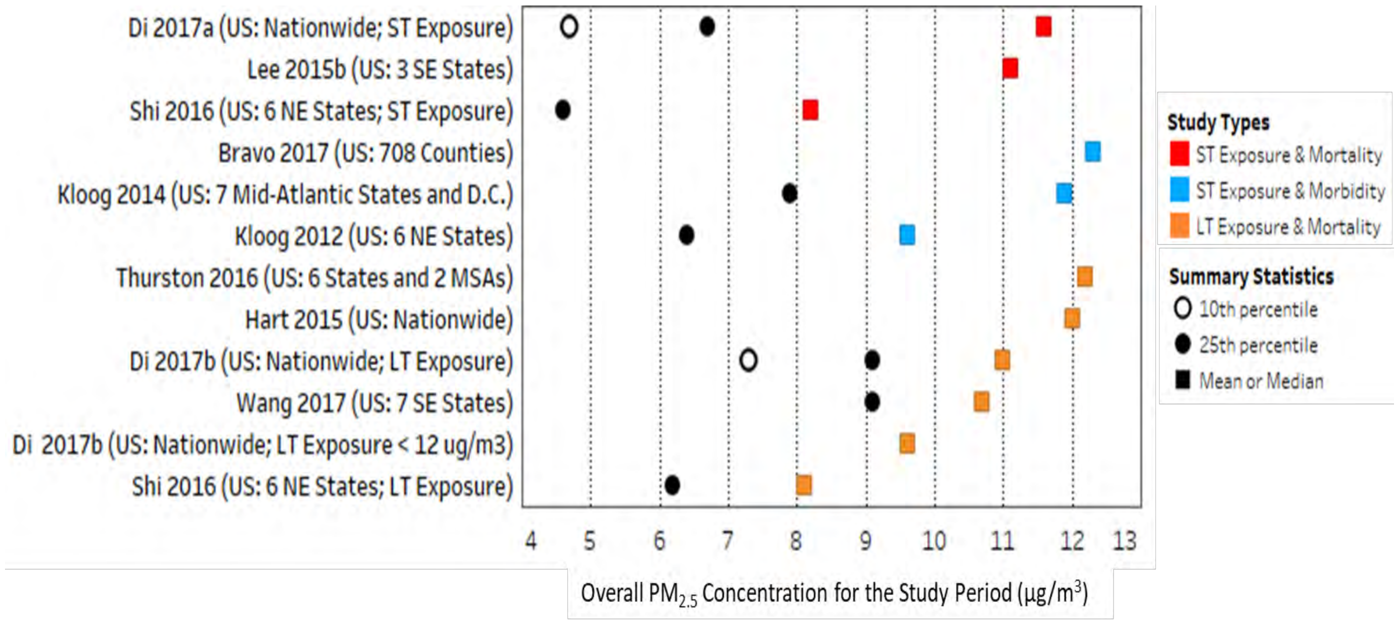
*Colored squares reflect overall study-reported mean (or median) $PM_{2.5}$ concentrations. Circles reflect the mean $PM_{2.5}$ concentrations corresponding to the 25th (filled) and 10th (open) percentiles of health events.

C183

$PM_{2.5}$ Concentrations in Epidemiologic Studies (Continued)

- Many new studies have used hybrid modeling approaches to estimate $PM_{2.5}$ exposures in monitored and unmonitored locations
- Approaches use information from multiple sources, potentially including satellites and models, in addition to ground-based monitors
- All of these key studies report positive and statistically significant associations and have overall mean $PM_{2.5}$ concentrations > 8.0 $\mu g/m^3$
- In most studies with data available, 75% of exposures (or deaths) are at predicted ambient $PM_{2.5}$ concentrations > 6.0 $\mu g/m^3$

Hybrid Model-Predicted $PM_{2.5}$ Concentrations



Uncertainties in using this information to inform conclusions on standards include:

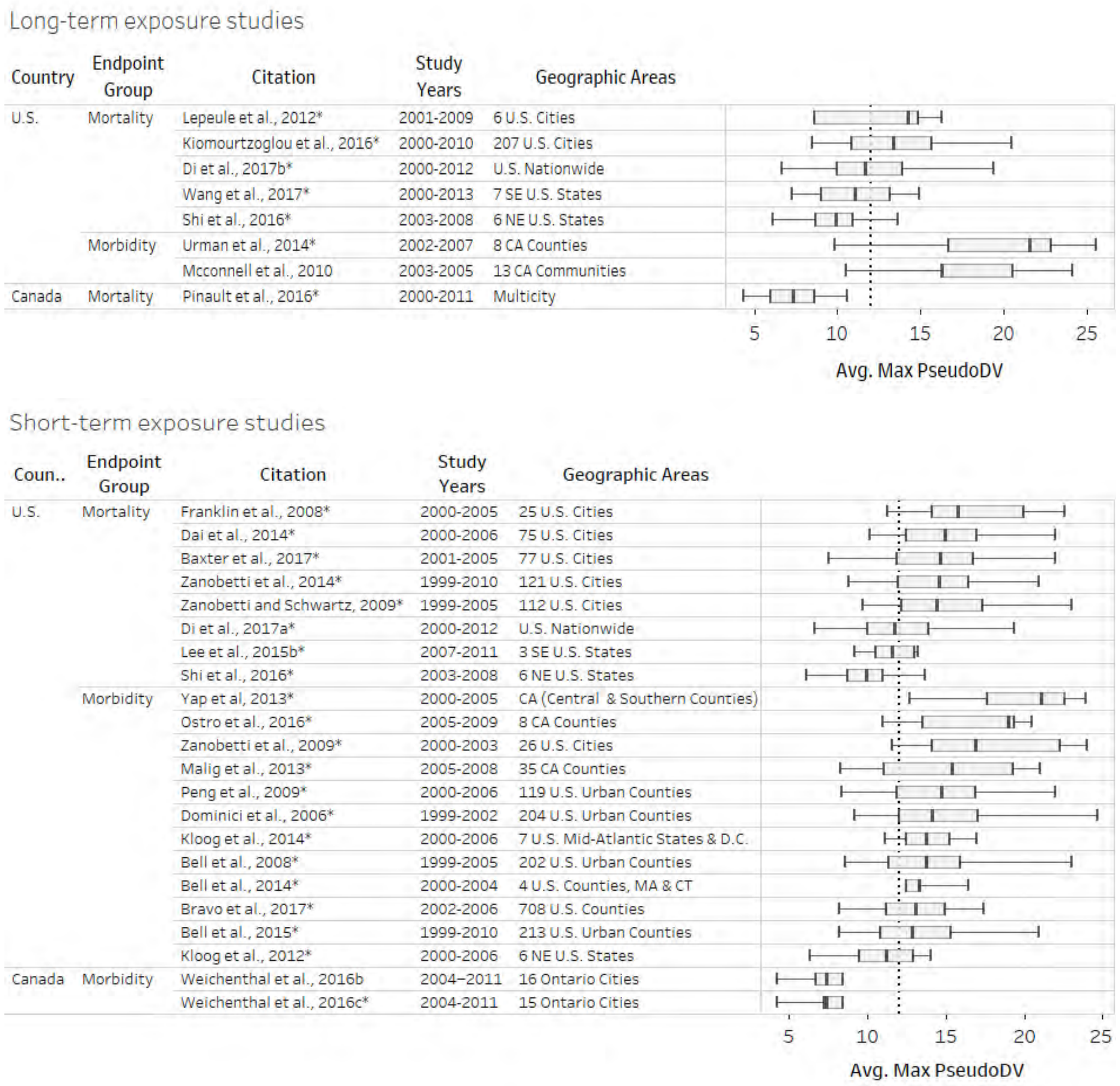
- Mean and lower quartile concentrations are not the same as those used by the EPA to compare with standard levels
- Studies have not identified a threshold concentration below which associations do not occur
- Hybrid model performance varies by location, with factors contributing to poorer performance (e.g., sparse monitoring) often coinciding with relatively low ambient $PM_{2.5}$ concentrations

*Colored squares reflect overall study-reported mean $PM_{2.5}$ concentrations. Circles reflect the mean $PM_{2.5}$ concentrations corresponding to the 25th (filled) and 10th (open) percentiles of exposures or deaths.

C184

$PM_{2.5}$ Annual Pseudo-Design Values in Locations of Key Studies

- The draft PA also identifies monitor-based metrics – similar to design values – in study locations (annual and 24-hr pseudo-design values)
- For most of the 29 key studies evaluated, ≥ about 25% of study area health events/populations were in locations that generally would have met both standards during study periods
- For 9 key studies, > 50% of study area health events/populations were in such locations
- For 4 key studies, > 75% of study area health events/populations were in such locations
- Uncertainties include:
  - Many studies examine a mix of locations and time periods meeting and violating standards
  - Values are not available in unmonitored areas
  - Values do not reflect current near-road monitoring requirements

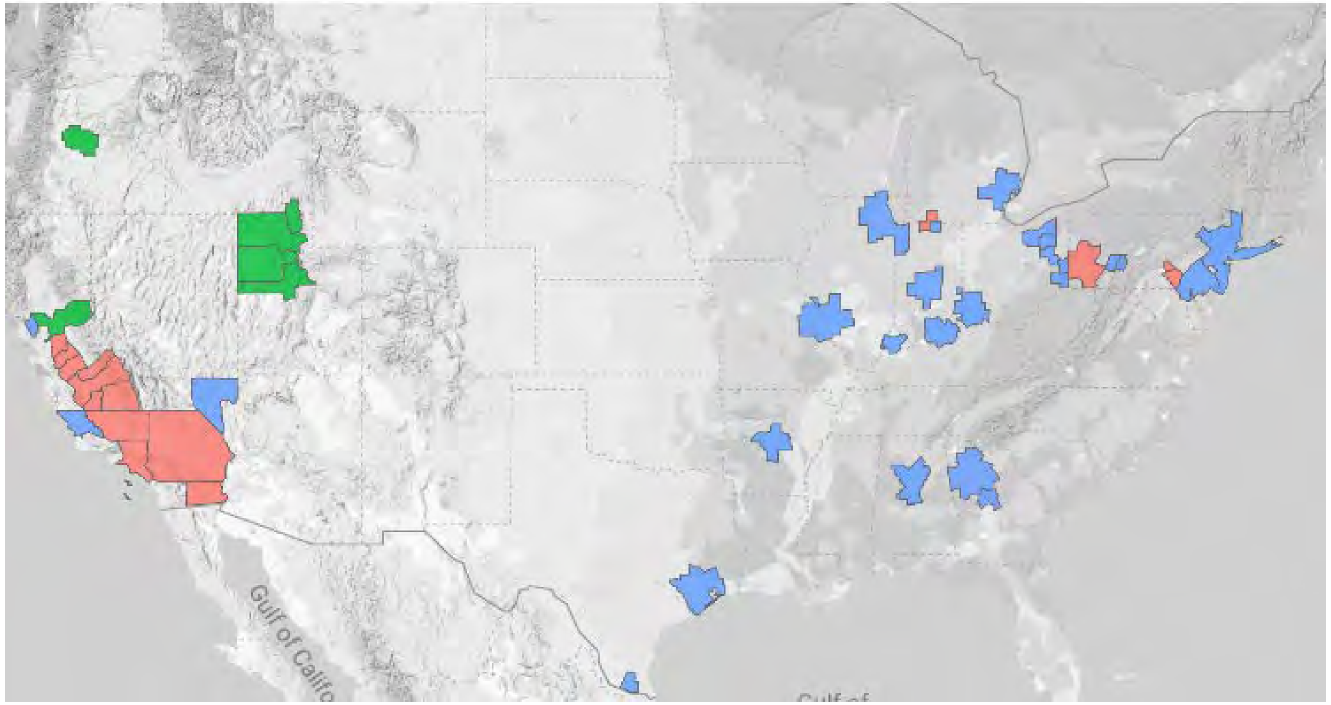


C185

 * Whiskers correspond to 5th and 95th percentiles, boxes correspond to 25th and 75th percentiles, central vertical lines correspond to 50th percentiles

$PM_{2.5}$ Risk Assessment

- Examined $PM_{2.5}$-associated mortality risk in 47 urban study areas
- Assessed current standards; alternative annual standards with levels of 11.0, 10.0, and 9.0 µg/m^3; alternative 24-hour standard with a level of 30 µg/m^3
- 2015 analysis year
- Examined two approaches to adjusting air quality
  - Focus on primary PM
  - Focus on secondary PM



47 urban study areas (population ≥ 30 years: ~60M)

- 30 annual-controlling (population ≥ 30 years: ~50M)
- 11 daily-controlling (population ≥ 30 years: ~4M)
- 6 mixed (population ≥ 30 years: ~5M)

Above 10 annual and 30 daily

Above 30 daily

Above 10 annual

C186

Summary of Risk Estimates

Estimates of $PM_{2.5}$-associated deaths in the full set of 47 study areas

Endpoint	Study	Air quality simulation approach*	Current Standad Absolute Risk (12/35 µg/m^3)	CS (12/35) % of baseline**	Alternative Standard Absolute Risk: Alternative Annual (10 µg/m^3)	Alternative Standard Absolute Risk: Alternative 24-hr (30 µg/m^3)
Long-term exposure related mortality						
Ischemic Heart Disease	Jerrett 2016	Pri-PM	16,500 (12,600-20,300)	14.1	14,400 (11,000-17,700)	16,400 (12,500-20,000)
		Sec-PM	16,800 (12,800-20,500)	14.3	14,200 (10,900-17,500)	16,500 (12,600-20,200)
	Pope 2015	Pri-PM	15,600 (11,600-19,400)	13.3	13,600 (10,100-17,000)	15,400 (11,500-19,200)
		Sec-PM	15,800 (11,800-19,600)	13.4	13,400 (9,970-16,700)	15,600 (11,600-19,400)
All-cause	Di 2017	Pri-PM	46,200 (45,000-47,500)	8.4	40,300 (39,200-41,400)	45,700 (44,500-47,000)
		Sec-PM	46,900 (45,600-48,200)	8.5	39,700 (38,600-40,800)	46,200 (44,900-47,500)
	Pope 2015	Pri-PM	51,300 (41,000-61,400)	7.1	44,700 (35,700-53,500)	50,700 (40,500-60,700)
		Sec-PM	52,100 (41,600-62,300)	7.2	44,000 (35,100-52,700)	51,300 (41,000-61,400)
	Thurston 2015	Pri-PM	13,500 (2,360-24,200)	3.2	11,700 (2,050-21,100)	13,300 (2,330-24,000)
		Sec-PM	13,700 (2,400-24,600)	3.2	11,500 (2,010-20,700)	13,500 (2,360-24,200)
Lung cancer	Turner 2016	Pri-PM	3,890 (1,240-6,360)	8.9	3,390 (1,080-5,560)	3,850 (1,230-6,300)
		Sec-PM	3,950 (1,260-6,460)	9.1	3,330 (1,060-5,470)	3,890 (1,240-6,370)
Short-term exposure related mortality						
All cause	Baxter 2017	Pri-PM	2,490 (983-4,000)	0.4	2,160 (850-3,460)	2,460 (970-3,950)
		Sec-PM	2,530 (998-4,060)	0.4	2,120 (837-3,400)	2,490 (982-3,990)
	Ito 2013	Pri-PM	1,180 (-16-2,370)	0.2	1,020 (-14-2,050)	1,160 (-16-2,340)
		Sec-PM	1,200 (-16-2,400)	0.2	1,000 (-14-2,020)	1,180 (-16-2,370)
	Zanobetti 2014	Pri-PM	3,810 (2,530-5,080)	0.7	3,300 (2,190-4,400)	3,760 (2,500-5,020)
		Sec-PM	3,870 (2,570-5,160)	0.7	3,250 (2,160-4,330)	3,810 (2,530-5,070)

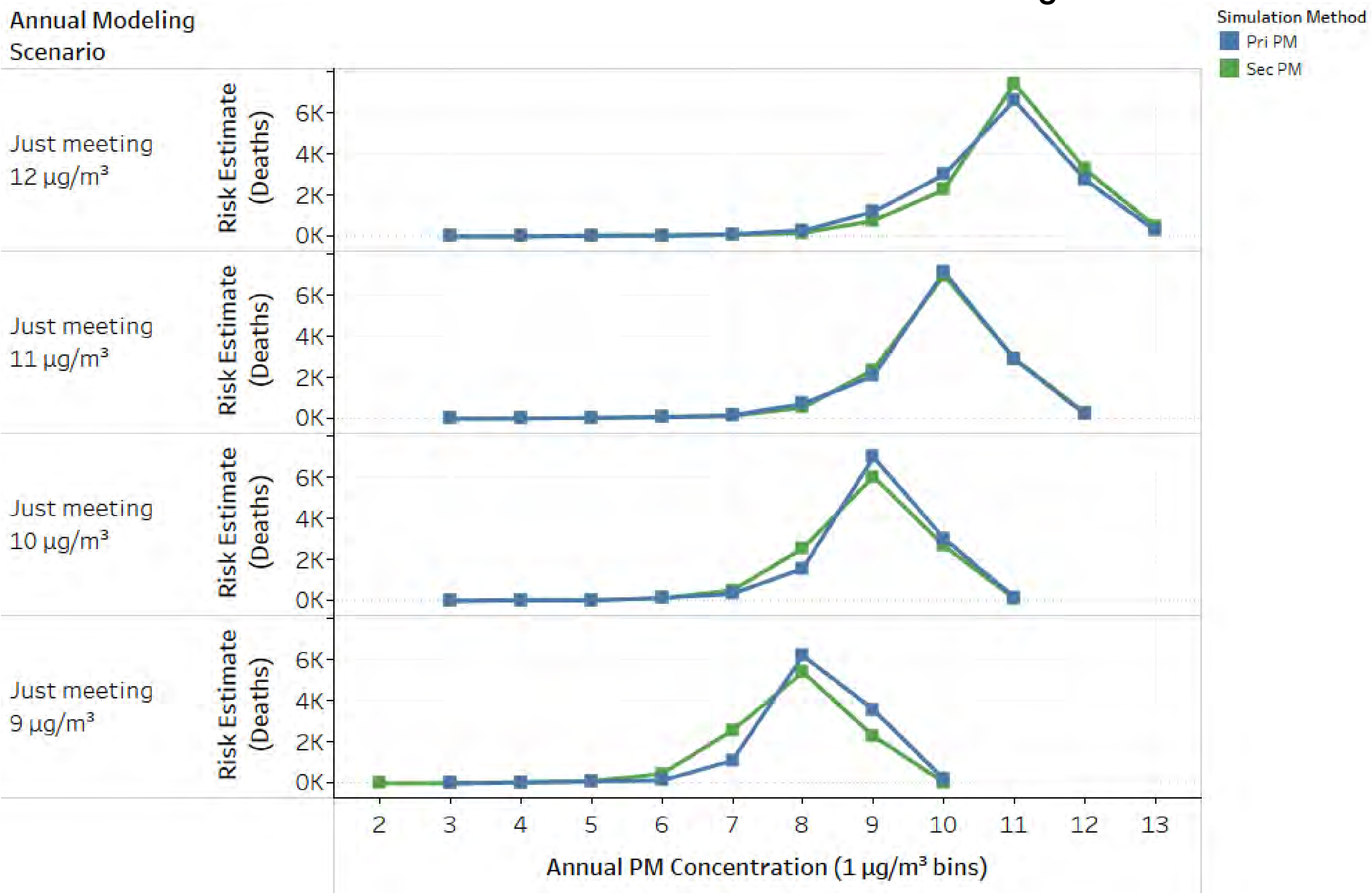
* Pri-PM (primary PM-based modeling approach), Sec-PM (secondary PM-based modeling approach)

** CS denotes the current standard.

C187

Summary of Risk Estimates (Continued)

Distributions of estimated risks in the 30 study areas where the annual standard is controlling*



Uncertainty in risk estimates results from uncertainties in the underlying epidemiologic studies, in the air quality adjustments, and in the application of study and air quality information to develop quantitative estimates of $PM_{2.5}$-associated mortality risks

*Estimates of ischemic heart disease deaths associated with long-term $PM_{2.5}$ exposures for air quality adjusted to simulate “just meeting” the current and alternative primary standards (based on Jerrett et al., 2016)

C188

Preliminary Conclusions on the Current Primary $PM_{2.5}$ Standards

- The available scientific information can reasonably be viewed as calling into question the adequacy of the public health protection afforded by the current annual and 24-hour primary $PM_{2.5}$ standards
- Basis for this preliminary conclusion:
  - Long-standing body of health evidence, strengthened in this review, supporting relationships between $PM_{2.5}$ exposures and various outcomes, including mortality and serious morbidity effects
  - Recent U.S. and Canadian epidemiologic studies reporting positive and statistically significant health effect associations for $PM_{2.5}$ air quality likely to be allowed by the current standards
  - Analyses of pseudo-design values indicating substantial portions of study area health events/populations in locations with air quality likely to have met the current $PM_{2.5}$ standards
  - Risk assessment estimates that the current primary standards could allow thousands of $PM_{2.5}$-associated deaths per year – most at annual average $PM_{2.5}$ concentrations from 10 to 12 $\mu g/m^3$ (well within the range of overall mean concentrations in key epidemiologic studies)

C189

Preliminary Conclusions on the Current Primary $PM_{2.5}$ Standards (Continued)

- In contrast, a conclusion that the current primary $PM_{2.5}$ standards do provide adequate health protection would place little weight on the epidemiologic evidence or the risk assessment
- Such a conclusion would place greater weight on uncertainties and limitations, including:
  - Increasing uncertainty in the biological pathways through which $PM_{2.5}$ exposures could cause serious health effects as the ambient concentrations being considered fall farther below the $PM_{2.5}$ exposure concentrations shown to cause effects in experimental studies
  - Increasing uncertainty in the potential public health impacts of air quality improvements as the ambient concentrations being considered fall farther below those present in accountability studies that document improving health with declining $PM_{2.5}$
    - Accountability studies evaluate air quality improvements with "starting" mean $PM_{2.5}$ concentrations (i.e., prior to the reductions evaluated) from ~13 to > 20 $\mu g/m^3$
  - Uncertainty in the risk assessment results from uncertainties in the underlying epidemiologic studies, in the air quality adjustments, and in the application of study and air quality information to develop quantitative estimates of $PM_{2.5}$-associated mortality risks

C190

Preliminary Conclusions on the Annual Standard Level

- If consideration is given to revising the primary $PM_{2.5}$ standards to increase public health protection, it would be appropriate to focus on lowering the level of the annual standard
- Support for particular levels depends on the weight placed on various aspects of the science and uncertainties
- For example, a level as low as 10.0 $\mu g/m^3$ could be considered if weight is placed on:
  - Setting a standard to maintain mean $PM_{2.5}$ concentrations below those in most key U.S. epidemiologic studies
  - Setting the standard level at or below the pseudo-design values corresponding to about the 50th percentiles of study area health event/populations in key U.S. studies
  - Setting a standard estimated to reduce $PM_{2.5}$-associated health risks, such that a substantial portion of the risk reduction is estimated at annual average $PM_{2.5}$ concentrations ≥ ~8 $\mu g/m^3$
- A level below 10.0 $\mu g/m^3$, potentially as low as 8.0 $\mu g/m^3$, could be supported to the extent more weight is placed on $PM_{2.5}$ health effect associations and estimated risks at lower concentrations and less weight is placed on uncertainties at lower concentrations

C191

Preliminary Conclusions on the 24-Hour Standard Level

- Purpose of the 24-hour standard is to provide protection against the short-term exposures to peak $PM_{2.5}$ concentrations, such as those that can occur in areas with strong contributions from local or seasonal sources even when overall mean concentrations remain relatively low

- In considering potential support for additional protection against short-term exposures to "peak" concentrations, we focus on the evidence from key epidemiologic studies and human clinical studies
  - Key epidemiologic studies do not indicate that $PM_{2.5}$ health effect associations are driven disproportionately by peak concentrations
  - Human clinical studies report effects following single short-term $PM_{2.5}$ exposures, but these studies generally examine exposures well above those measured in areas meeting the current standards

- Thus, the evidence provides little support for the need to provide additional protection against short-term peak concentrations in areas meeting the current 24-hour standard and the current, or revised (i.e., with a lower level), annual standard

C192

Additional Information

Two-Hour $PM_{2.5}$ Concentrations

- In human clinical studies, statistically significant effects on one or more indicators of cardiovascular function are often, though not always, reported following 2-hour exposures to average $PM_{2.5}$ concentrations at and above about 120 μg/m^3
- There is less consistent evidence for effects following exposures to lower concentrations

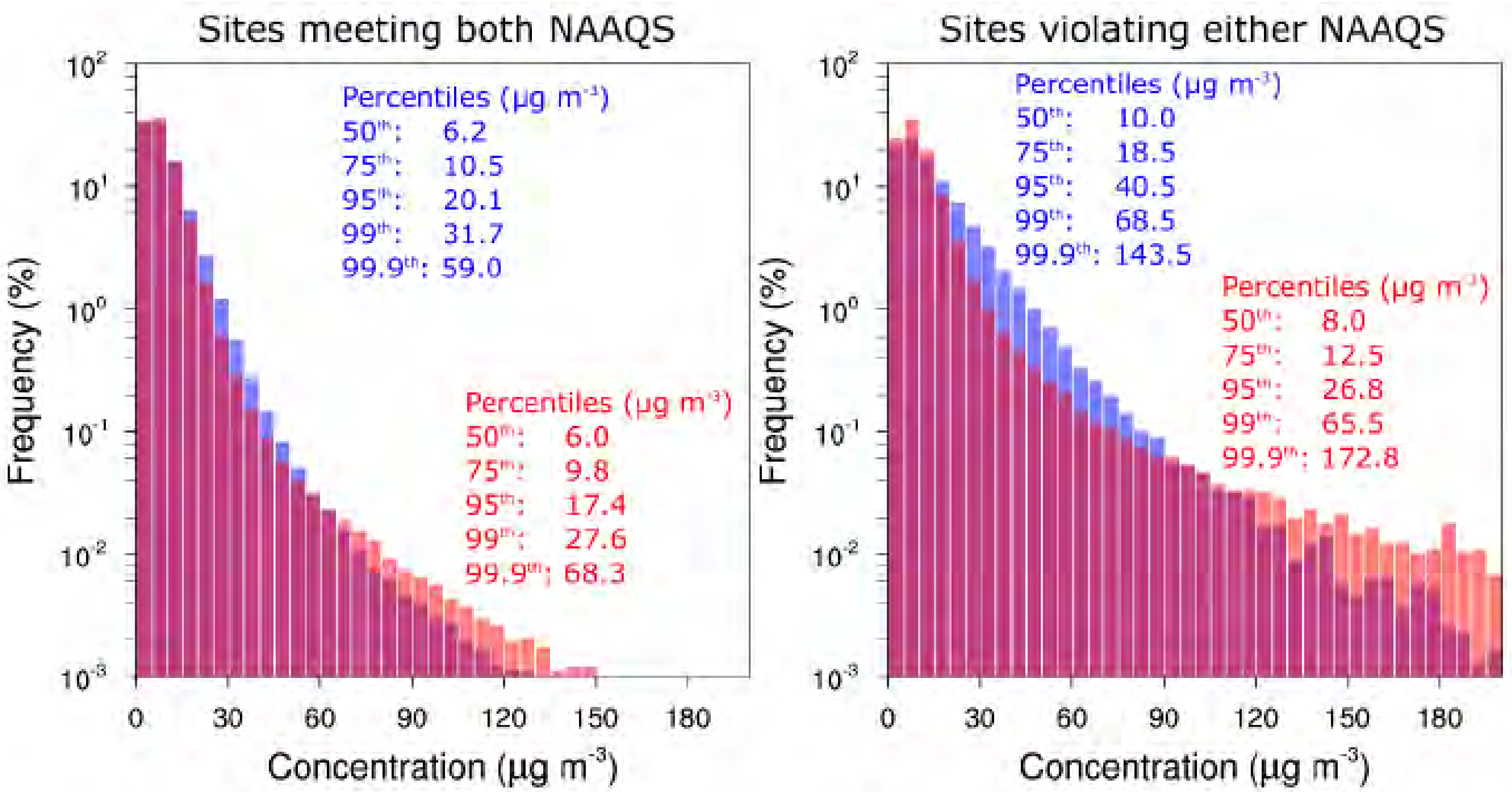
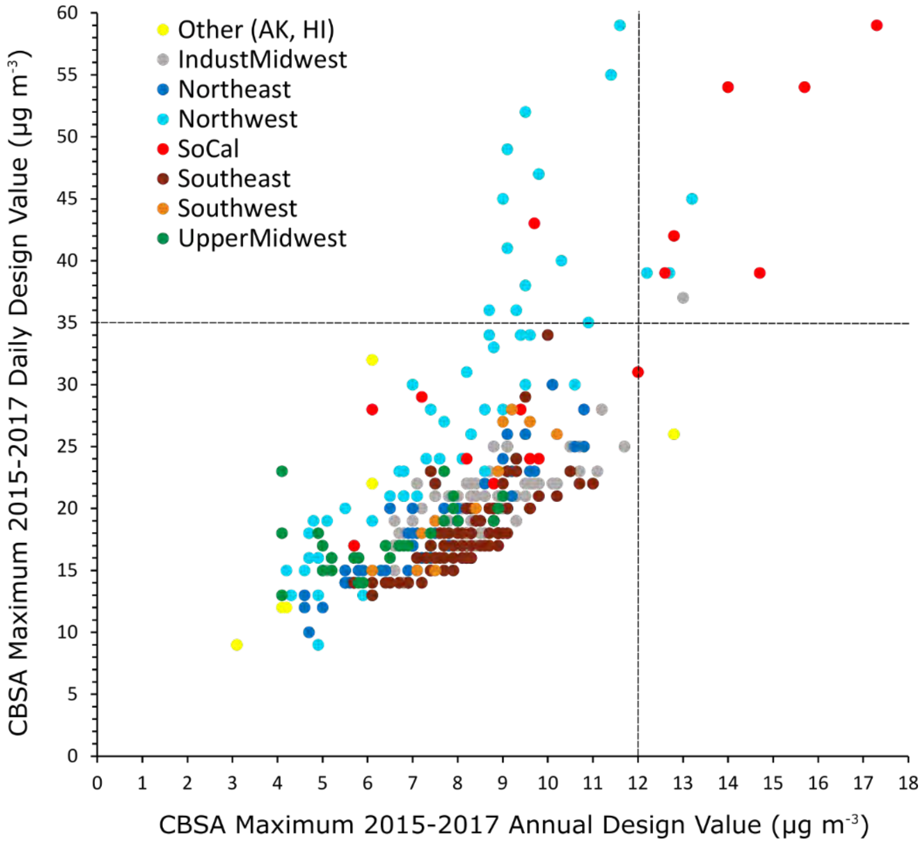


Figure 2-14.Frequency distribution of 2015-2017 2-hour averages for sites meeting or violating the annual $PM_{2.5}$ NAAQS for October to March (blue) and April to September (red).

C194

Annual and 24-Hour DVs

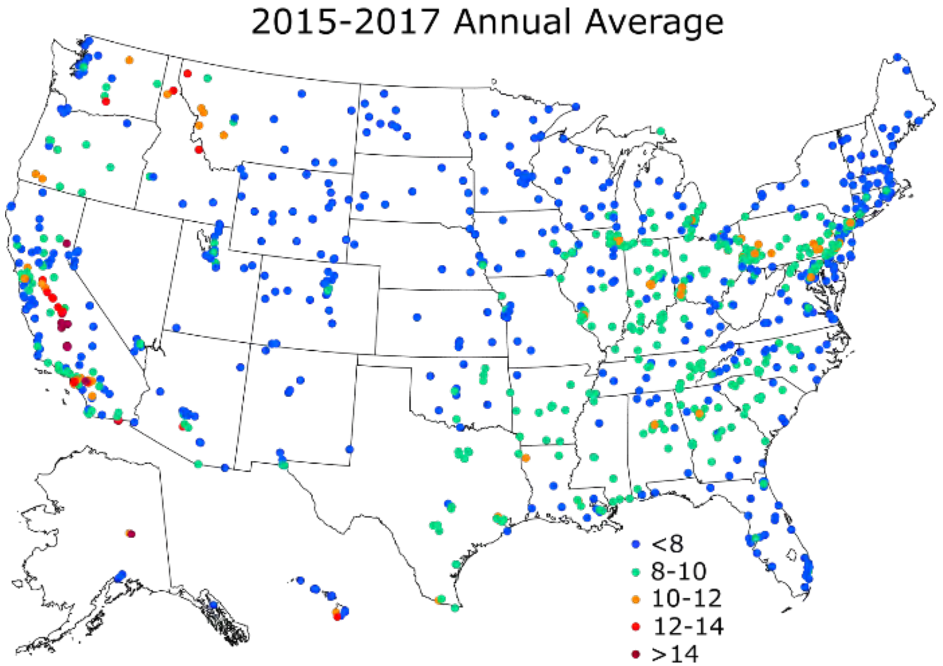


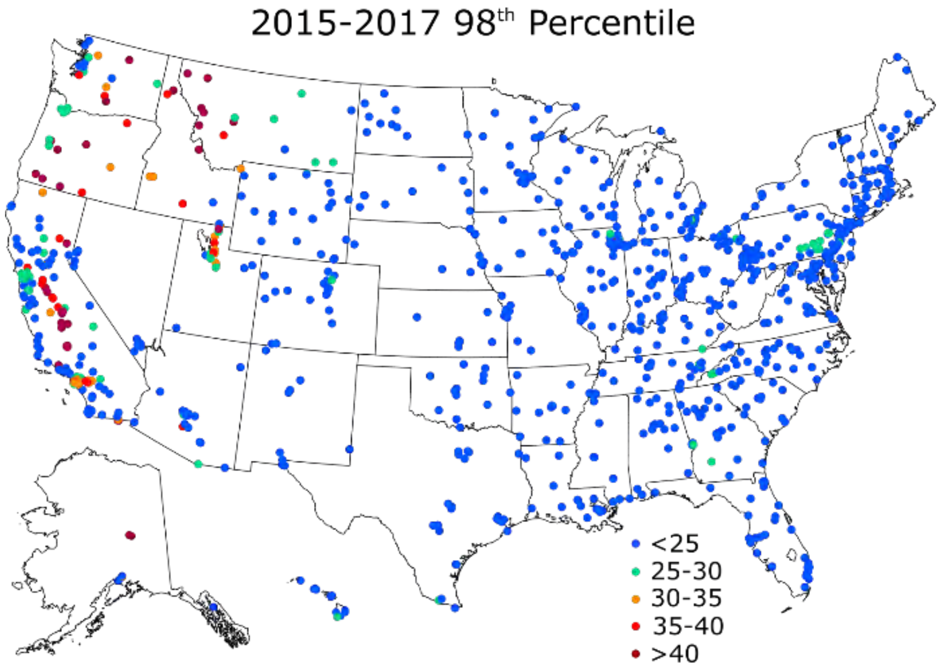
Draft PA Figure 2-11

It is likely that some of the annual and daily design values above are impacted by potential exceptional events associated with wildfire smoke that have yet to be removed from the calculations.

C195

$PM_{2.5}$: Recent Concentrations

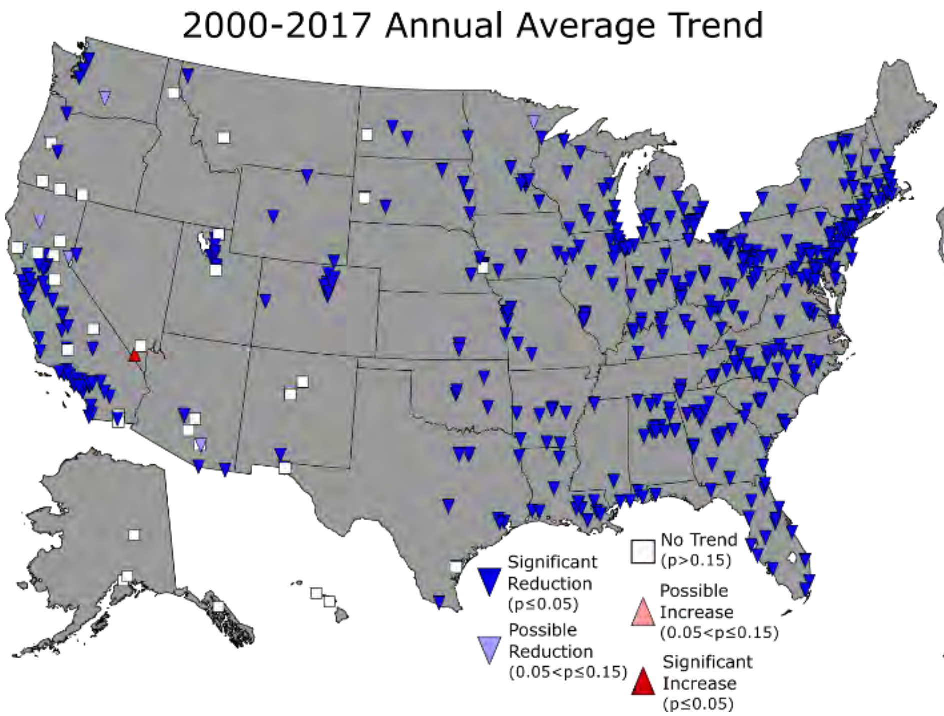


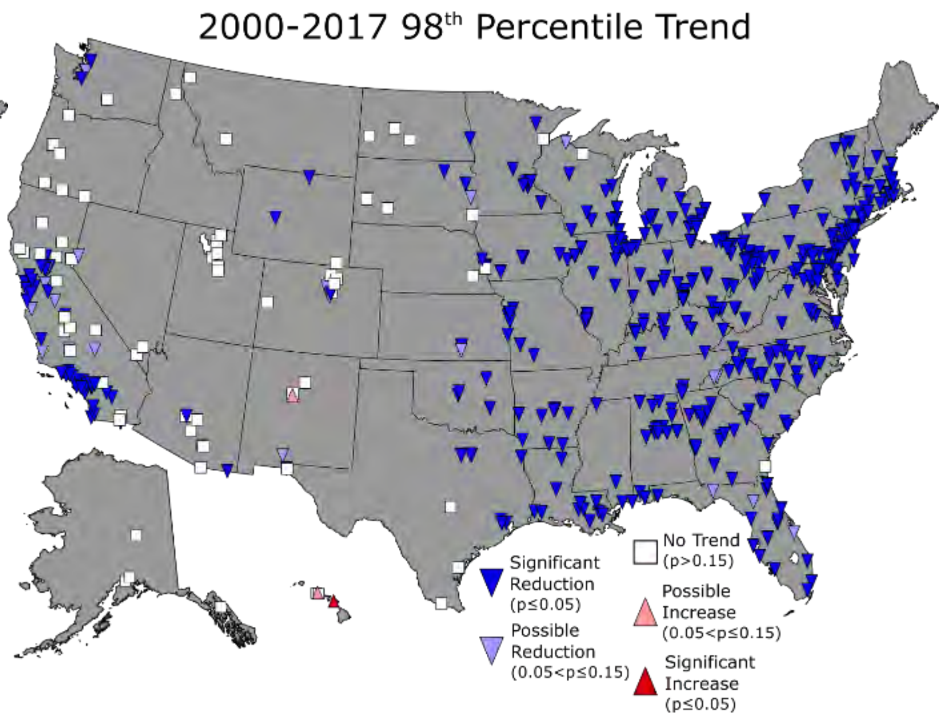


- Highest annual average and 98th percentile $PM_{2.5}$ concentrations are in California
- Fires in the Northwest were frequent during the 2015-2017 period
- Most Eastern sites had annual average and 98th percentile values below 10 and 25 μg m^{-3}, respectively

C196

$PM_{2.5}$ Trends





- The annual average and 98th percentile values have decreased over much of the Eastern US since 2000
- In the Western US, many sites have had no trend in the 98th percentile values in part because of the impact of meteorology and wildfires

C197

Key $PM_{2.5}$-Related Health Outcomes Considered in the Draft PA

Exposure Duration	Outcome	2009 ISA Conclusion	2018 Draft ISA Conclusion
Long-Term	Mortality	Causal	Causal
	Cardiovascular	Causal	Causal
	Respiratory	Likely to be causal	Likely to be causal
	Cancer	Suggestive	Likely to be causal
	Nervous System	None	Likely to be causal
Short-Term	Mortality	Causal	Causal
	Cardiovascular	Causal	Causal
	Respiratory	Likely to be causal	Likely to be causal

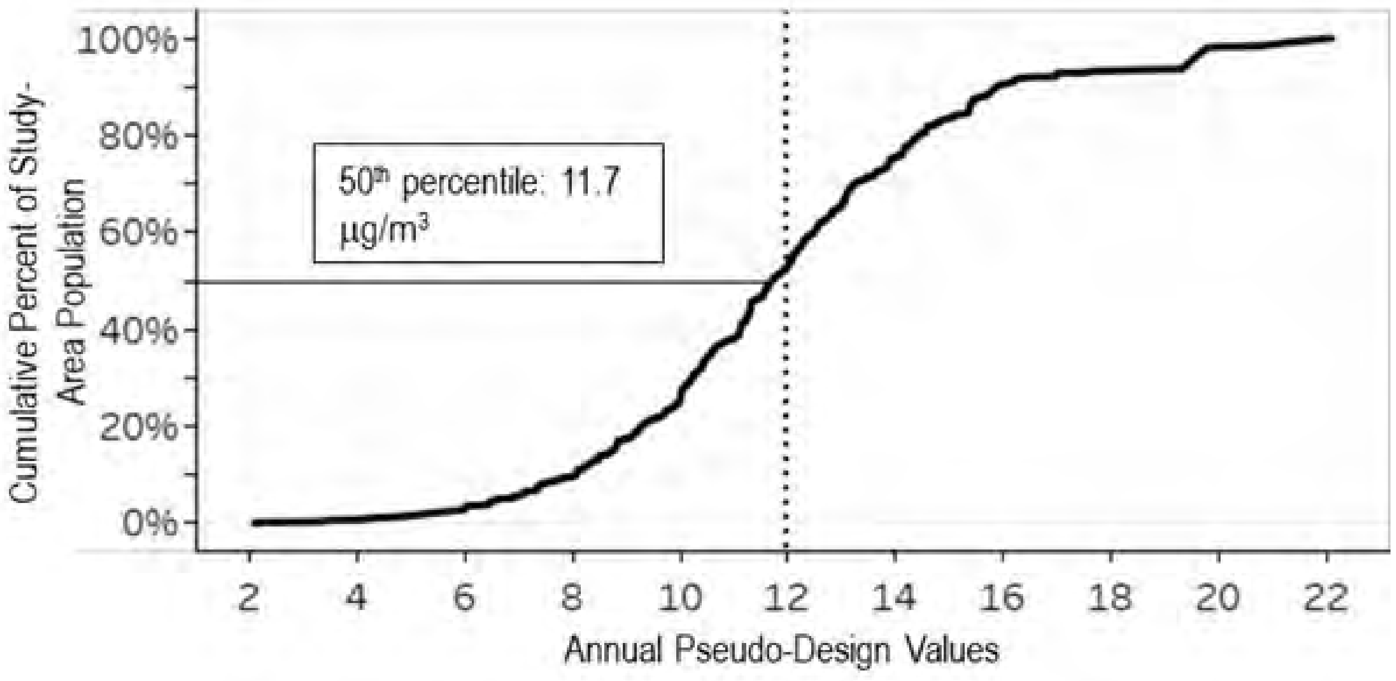
C198

Calculation of $PM_{2.5}$ Pseudo-Design Values

Approach

- Identify study areas (counties/cities) with sufficient monitoring data to calculate pseudo-design values
- For each monitored area and each 3-yr period of the study, identify the highest monitored $PM_{2.5}$ value
- For each monitored area, calculate the study-period average of these highest values
- Link study locations to study populations or health events
- Arrange study locations by ascending pseudo-design values
- Identify the cumulative percent of population or health events in study locations with various pseudo-design values

Example for Di et al. (2017)



C199

Particulate Matter:
Spotlight on Health Protection

Phil Martien, Ph.D.

- Director of the Assessment, Inventory, & Modeling Division at the Bay Area Air Quality Management District
- Leading role in the Technical Assessment of AB617’s West Oakland Community Action Plan
- Leading role in the Technical Assessment of the Air District’s 2017 Clean Air Plan: Spare the Air, Cool the Climate
- Leading role in the Air District's Community Air Risk Evaluation Program
- Ph.D. from UC Berkeley

Targeting Particulate Matter: West Oakland Community Emissions Reduction Program

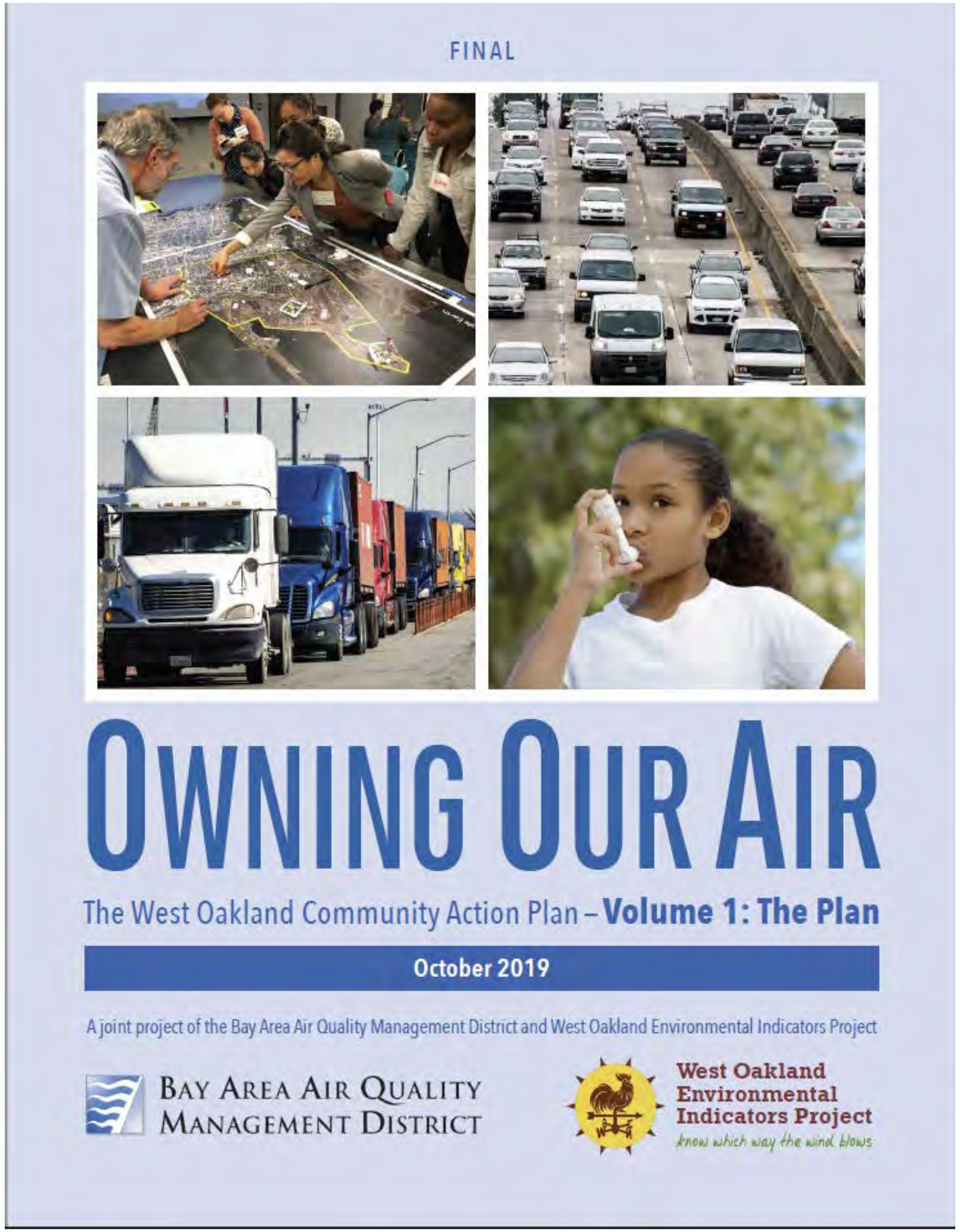
Bay Area Air Quality Management District

West Oakland Environmental Indicators Project
know which way the wind blows

Phil Martien, PhD
Bay Area Air Quality Management District
Particulate Matter: Spotlight on Health Protection
October 28, 2019

Acknowledgements

- Bay Area Air Quality Management District
- West Oakland Environmental Indicators Project
- West Oakland Steering Committee
- California Air Resources Board



Assessment of Particulate Matter (PM) in West Oakland

- **Motivation**
  - Implementing Assembly Bill (AB) 617: West Oakland Community Emissions Reduction Program
- **Modeling-based assessment approach**
- **Findings**
  - Source contributions to impacts
  - Equity-based targets
  - Effective emission reduction measures

West Oakland

Motivation

Implementing AB 617

- Address environmental justice concerns: higher air pollution in some communities
- Key mandates:
  - Local air districts to partner with community groups
  - Identify top sources of community impacts
  - Develop and implement plans to reduce emissions

C206

West Oakland: Year 1 Community Emissions Reduction Plan

West Oakland Environmental Indicators Project
know which way the wind blows

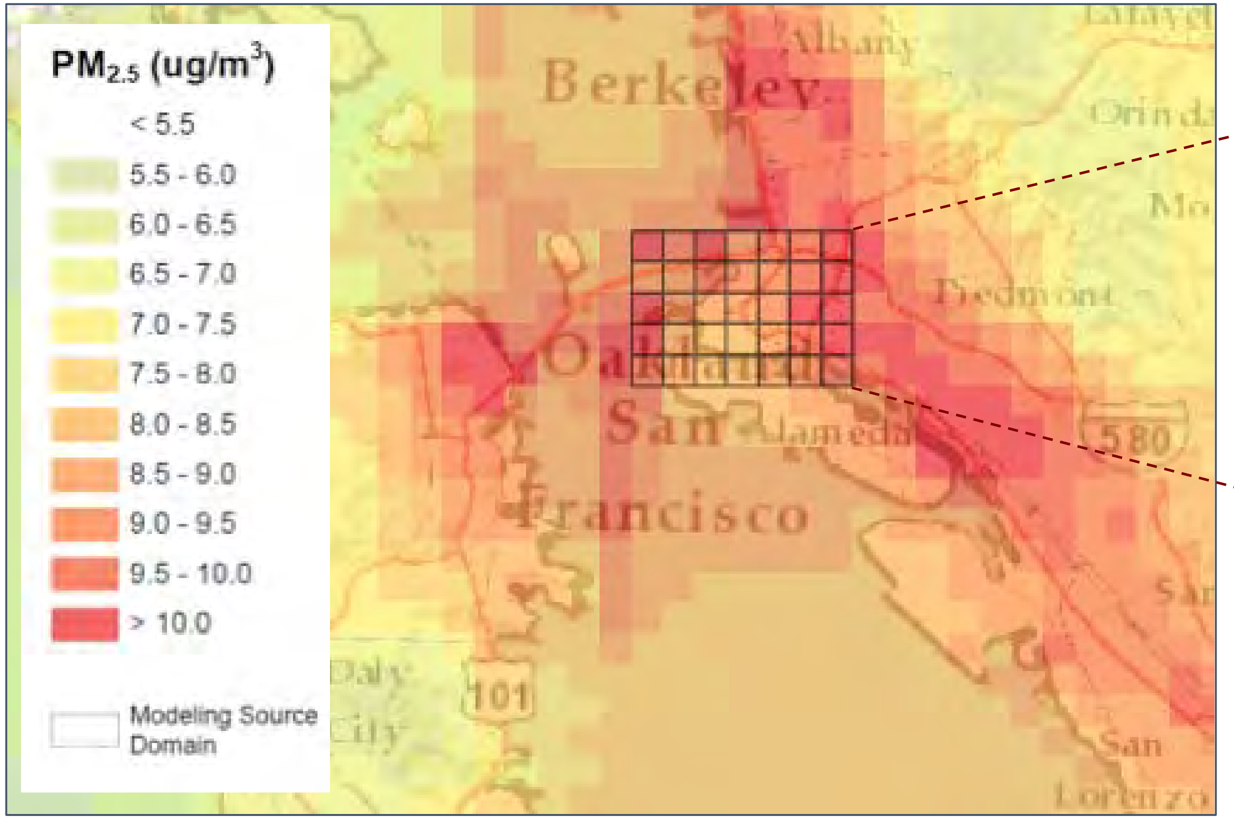
- Established partner: WOEIP has decades of experience

- High mobile-source emissions
  - Adjacent to the Port of Oakland
  - Surrounded by the I-880, I-80, I-580, and I-980 freeways
  - Industrial sources

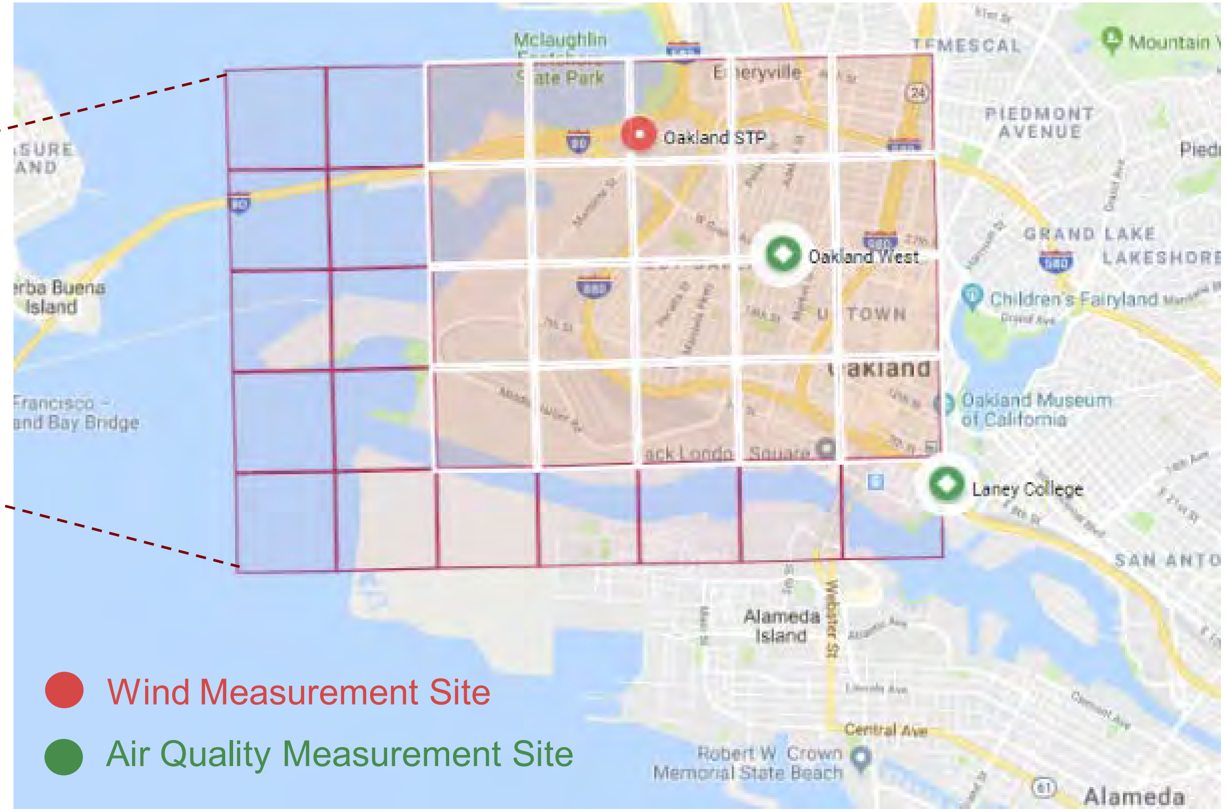
- High health burdens and socio-economic vulnerabilities

Assessment Approach

Regional-Scale and Community-Scale Modeling (2017)



Regional-scale modeling: covers the Bay Area



Local-scale modeling: covers West Oakland, including impacts in receptor area (white) from sources in source area (red)

C209

Pollutants

- $PM_{2.5}$
- Diesel PM
- Air toxics (cancer risk)

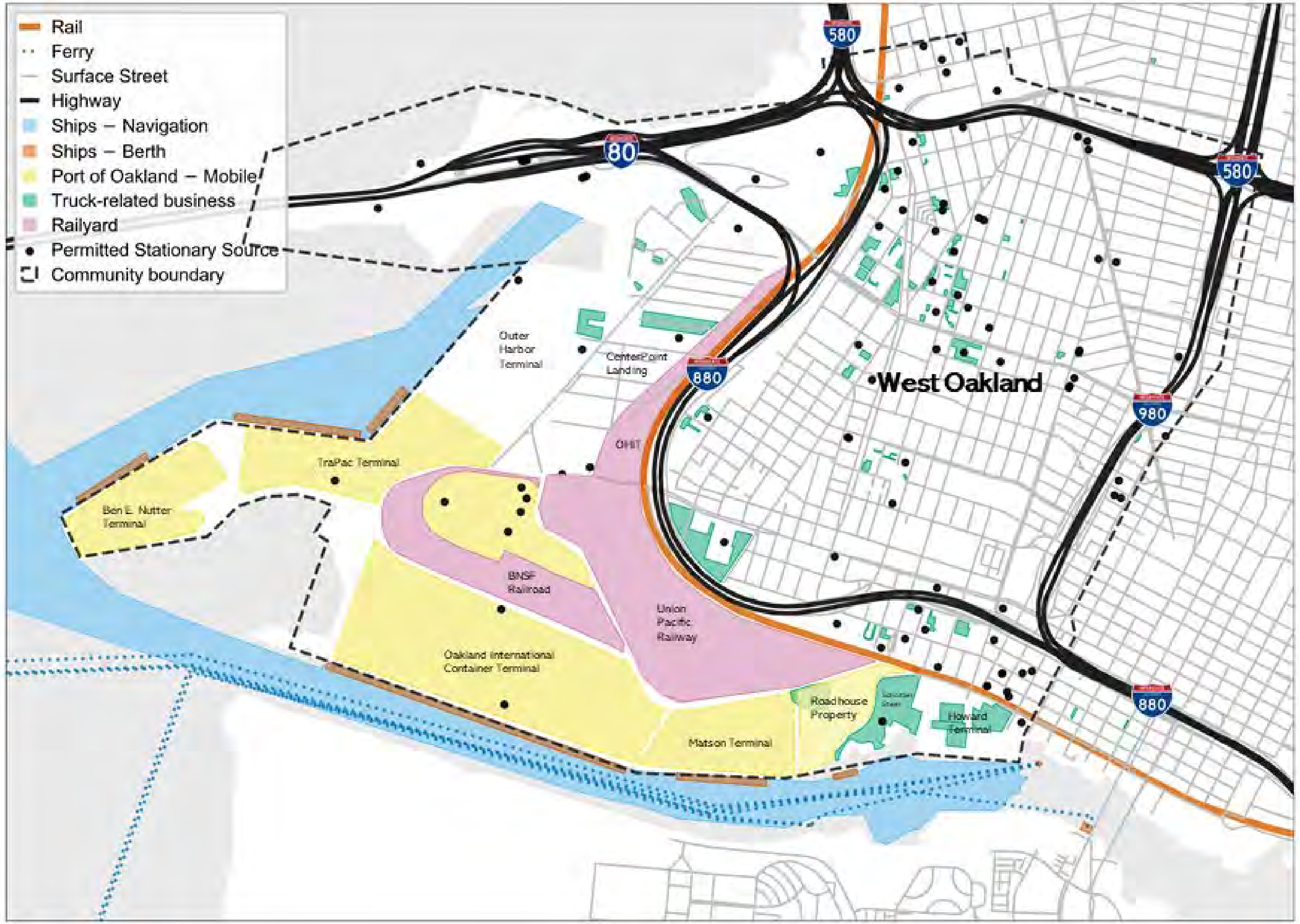
Sources modeled

- Port of Oakland and marine
- Railyards and trains
- Vehicles on freeways, streets
- Truck-related businesses
- Permitted stationary sources

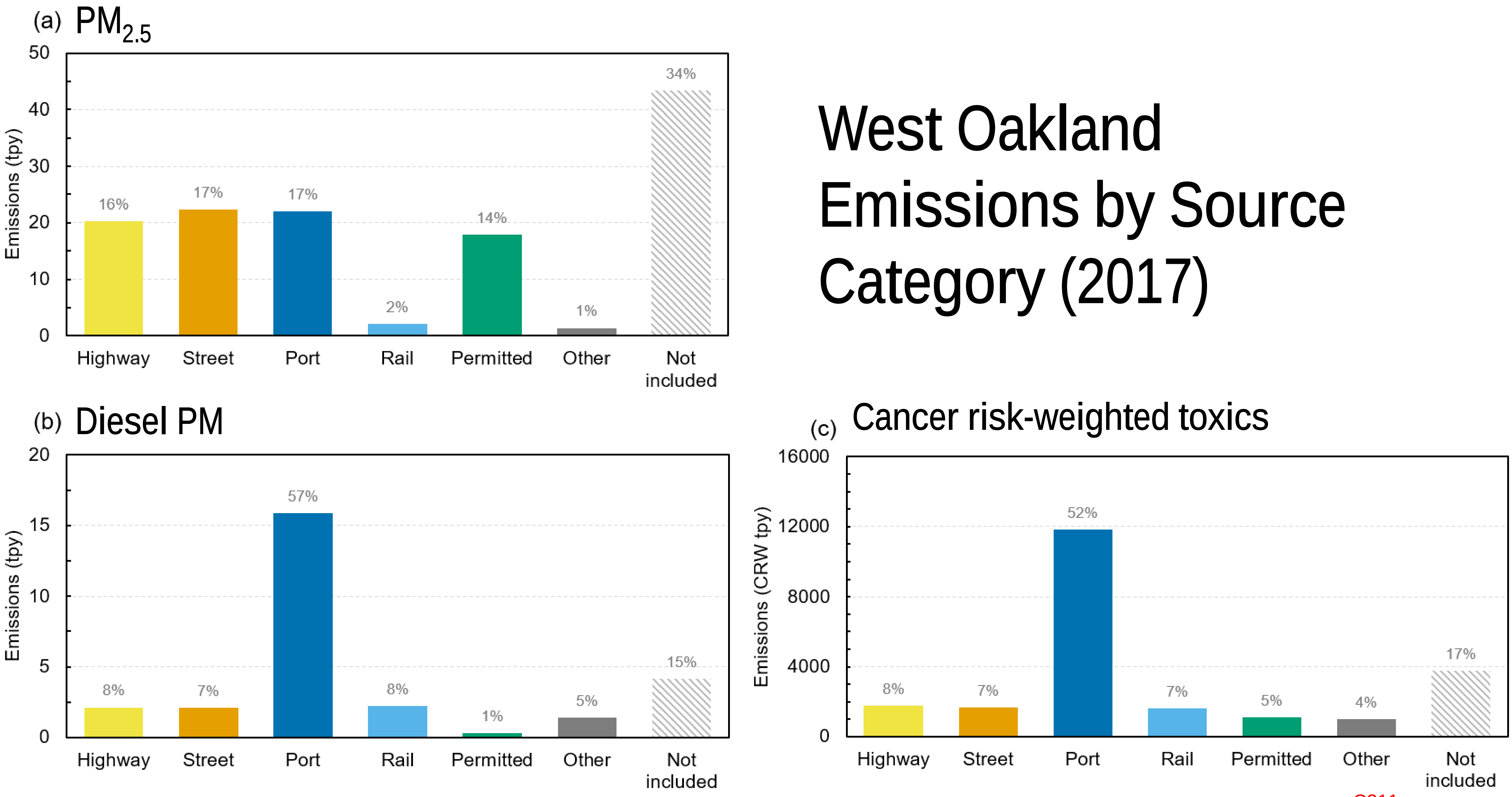
Not modeled

- Construction, residential woodburning, and restaurants

Community-Scale Modeling



West Oakland Emissions by Source Category (2017)



C211

Impact Varies by Location

Local Impact Zones

Local Impact Zones

1. Lower bottom/West Prescott
2. Third Street
3. Seventh Street
4. Acorn
5. Upper Adeline
6. Clawson
7. West Grand and San Pablo

Black Carbon above Median (Env. Def. Fund, 2019-01-13)

C213

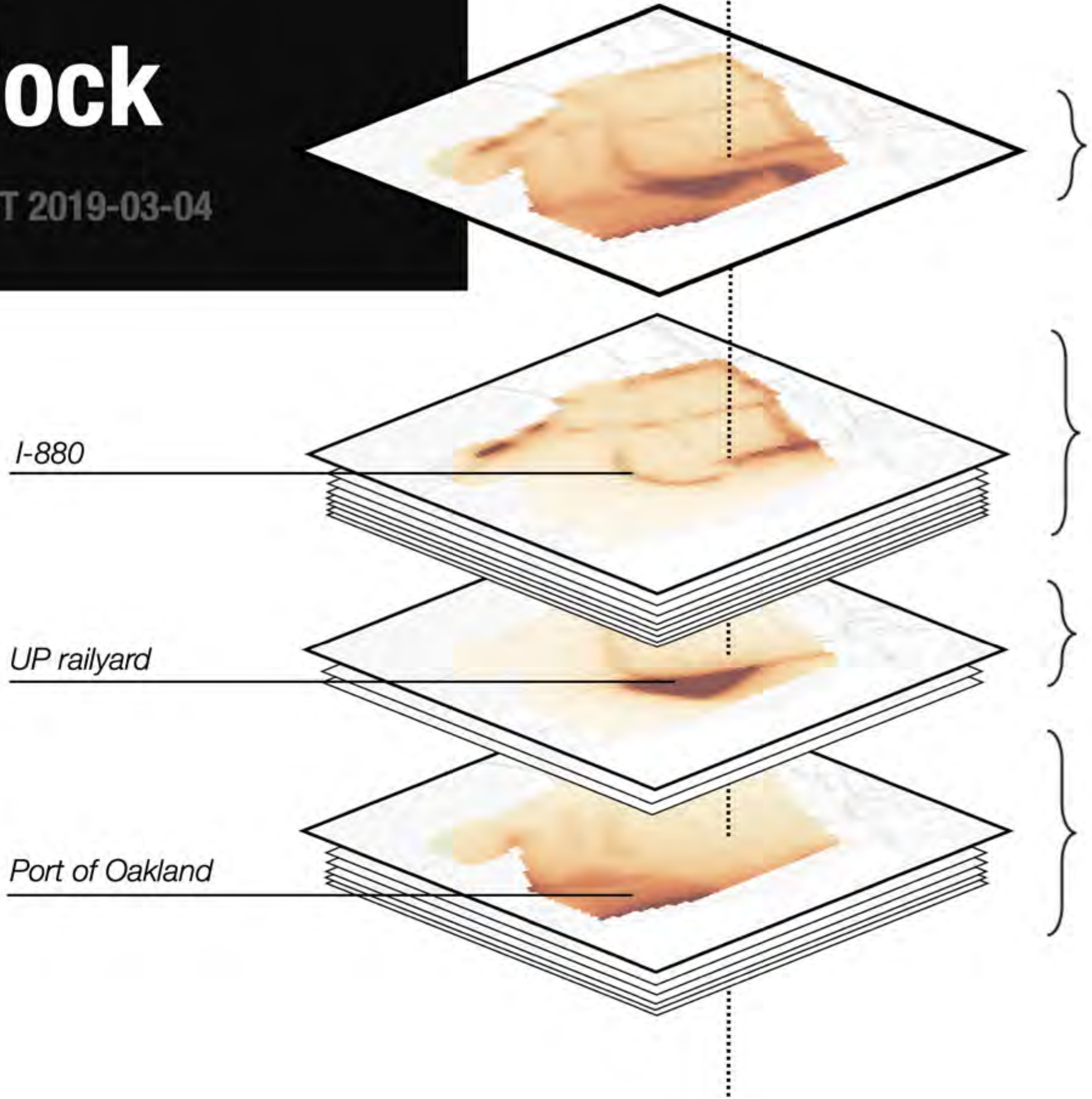
Impact Zones
on Census Blocks

C214

Source Apportionment

Block by Block

DRAFT 2019-03-04

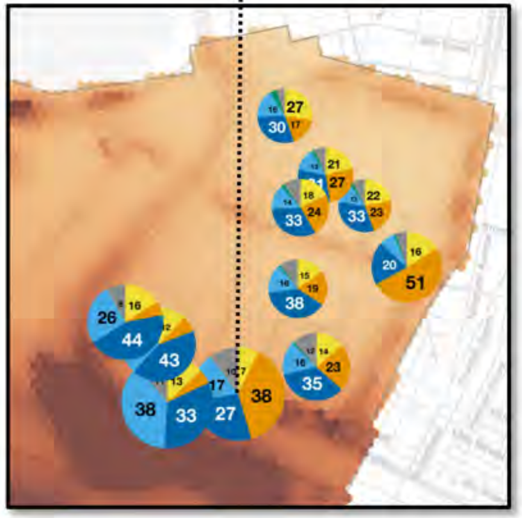


Grand total of modeled impacts from local sources

Sub-total from trucks, cars, and other vehicles on streets and highways

Sub-total from locomotive engines and railyards

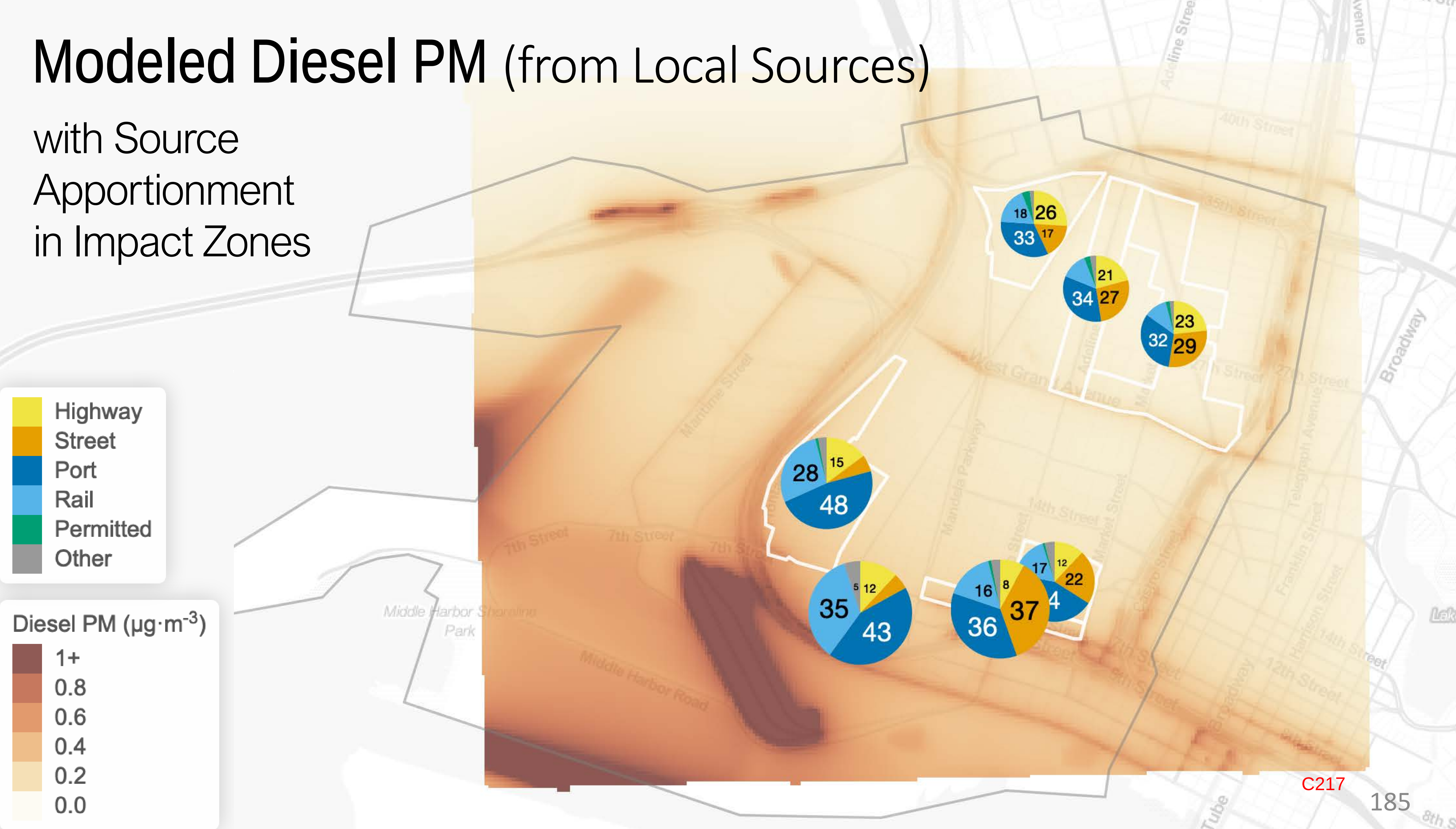
Sub-total from harbor craft, ocean-going vessels, drayage, cargo handling, etc.



For any location, we can use the sub-totals to draw piecharts showing the relative impacts of sources A, B, C, etc.

Modeled Diesel PM (from Local Sources)

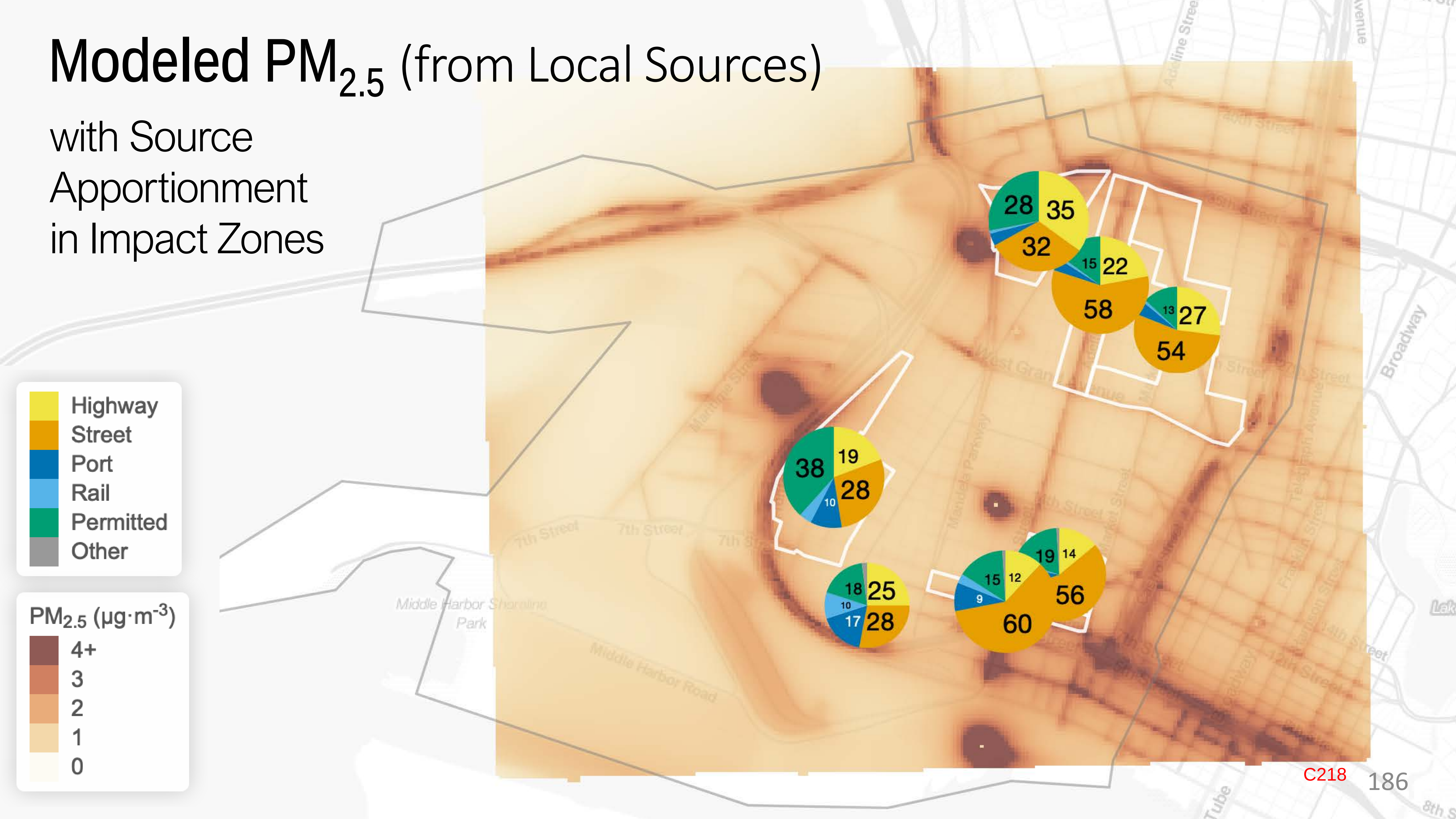
with Source Apportionment in Impact Zones



C217

Modeled $PM_{2.5}$ (from Local Sources)

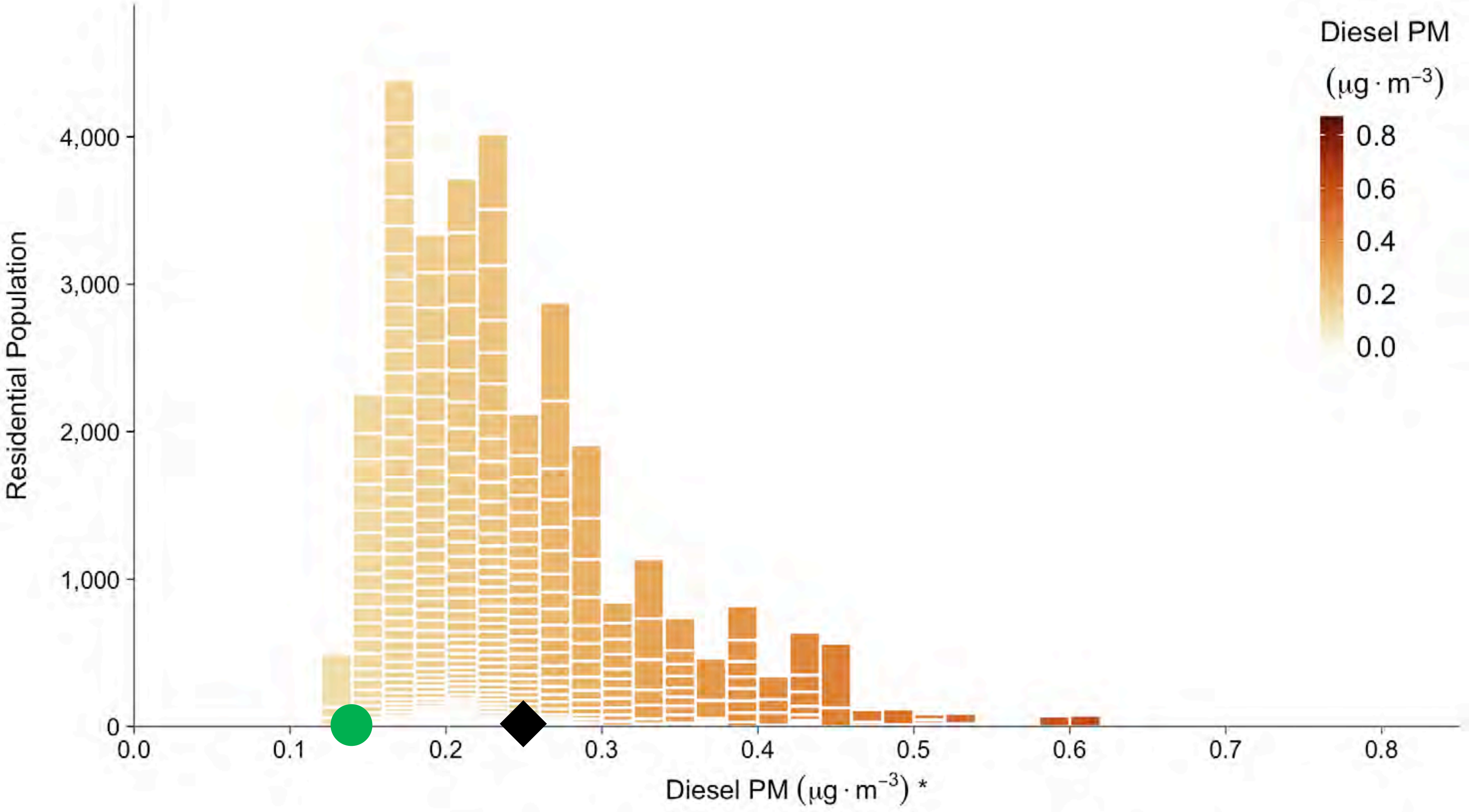
with Source Apportionment in Impact Zones



C218

Equity-Based Targets

Unequal Impacts: Diesel PM Across West Oakland

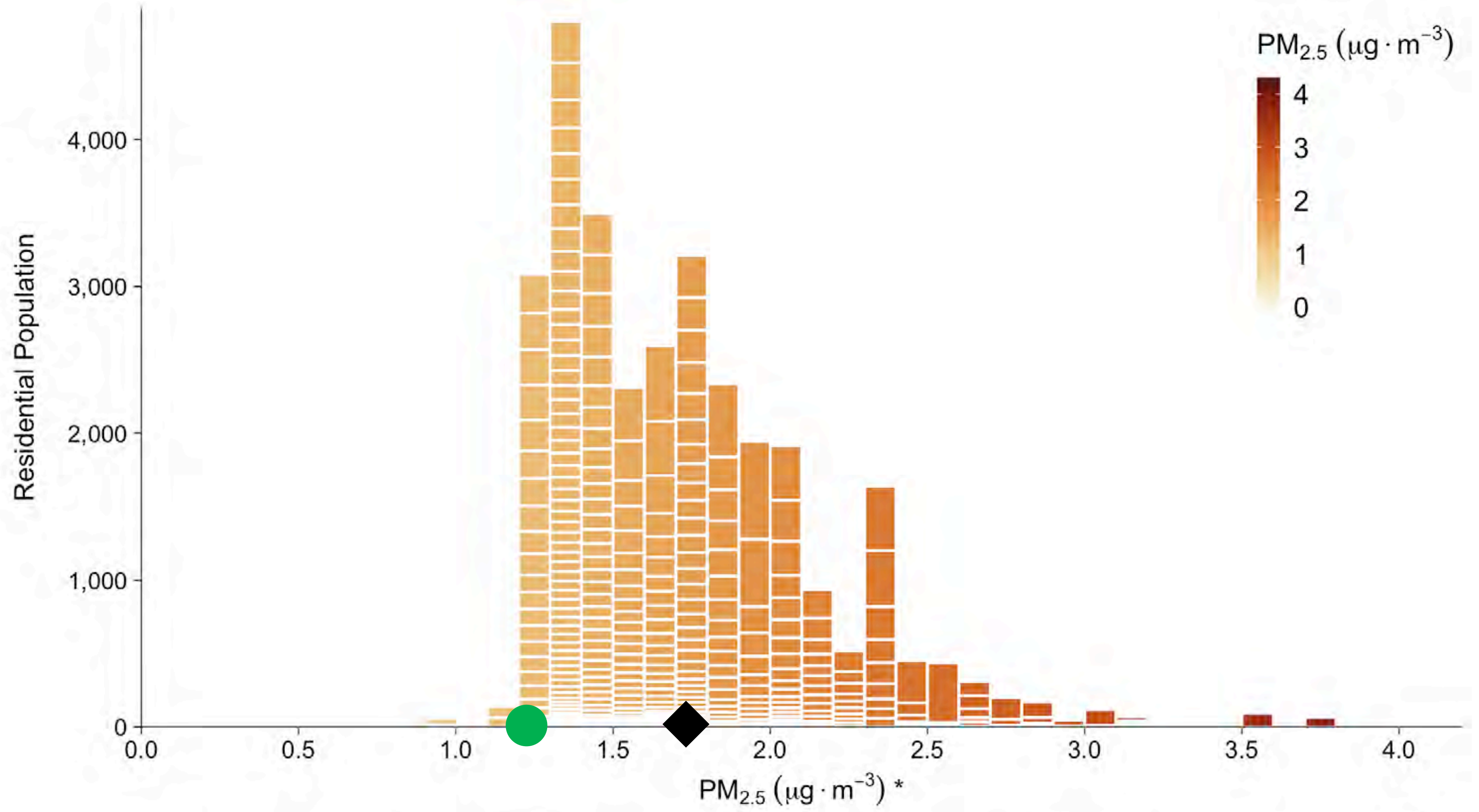


* Contributed by modeled "present-day" emissions from existing local sources. Impacts from sources outside West Oakland not included.

DRAFT 2019-08-16

C220

Unequal Impacts: $PM_{2.5}$ Across West Oakland



* Contributed by modeled "present-day" emissions from existing local sources. Impacts from sources outside West Oakland not included.

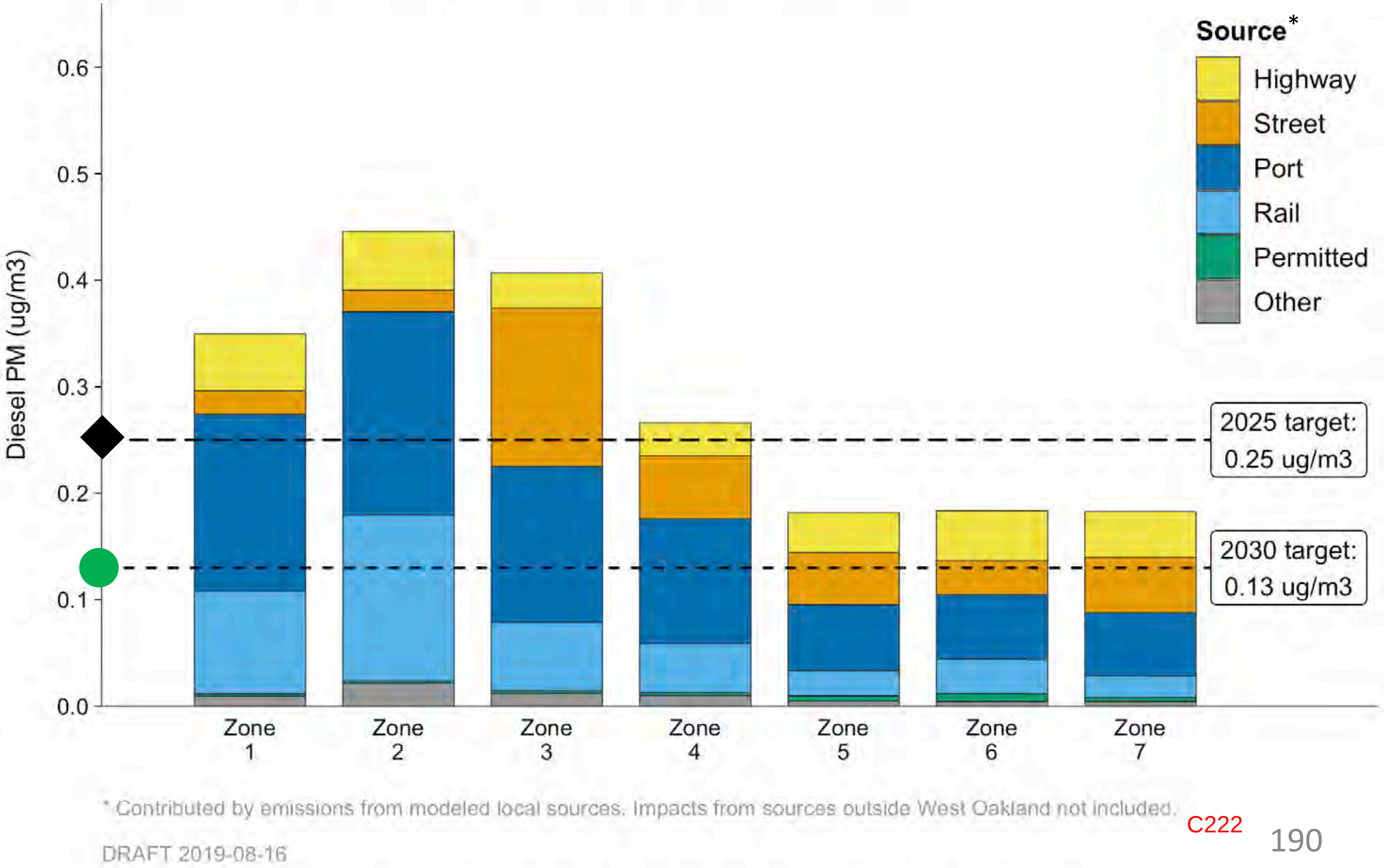
DRAFT 2019-08-16

Targets and Source Contributions for Diesel PM

Targets:

2025 – Today's *average* residential neighborhood

2030 – Today's *cleanest* residential neighborhood

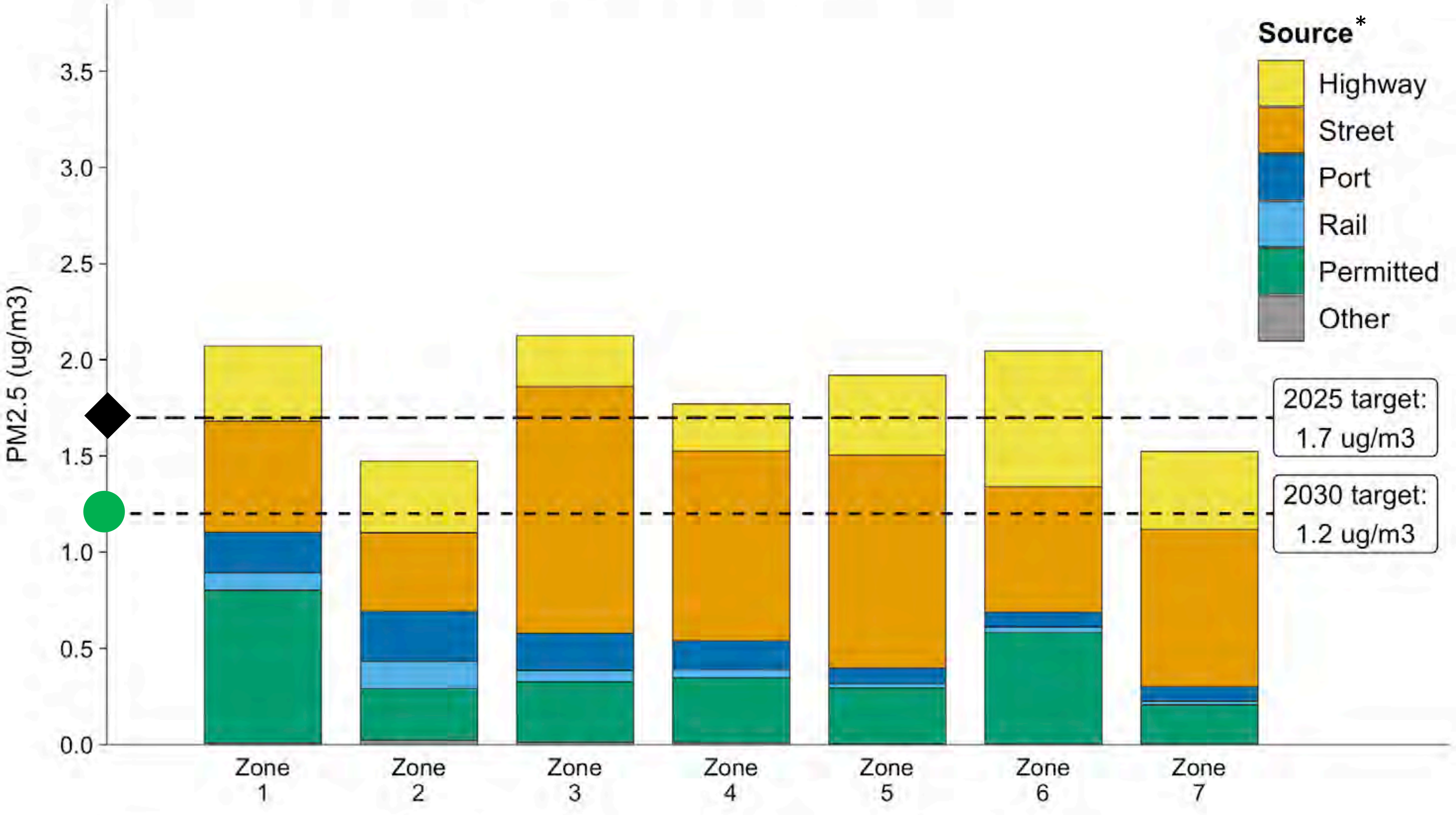


Targets and Source Contributions for $PM_{2.5}$

Targets:

2025 – Today's *average* residential neighborhood

2030 – Today's *cleanest* residential neighborhood



* Contributed by emissions from modeled local sources. Impacts from sources outside West Oakland not included.

DRAFT 2019-08-16

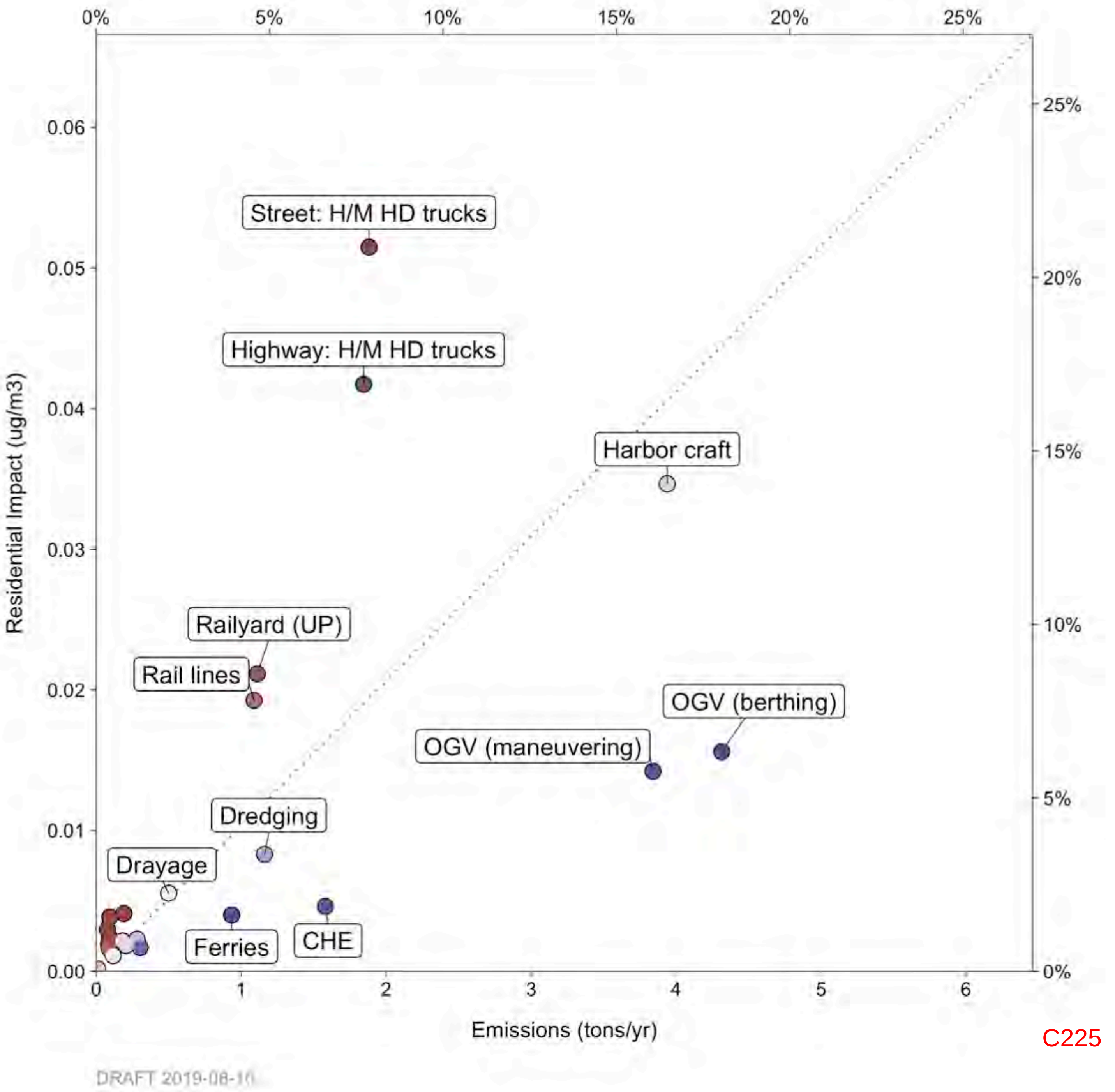
C223

Impact Per Ton Varies by Source

What Moves the Needle?

Impact Per Ton: Diesel PM in West Oakland

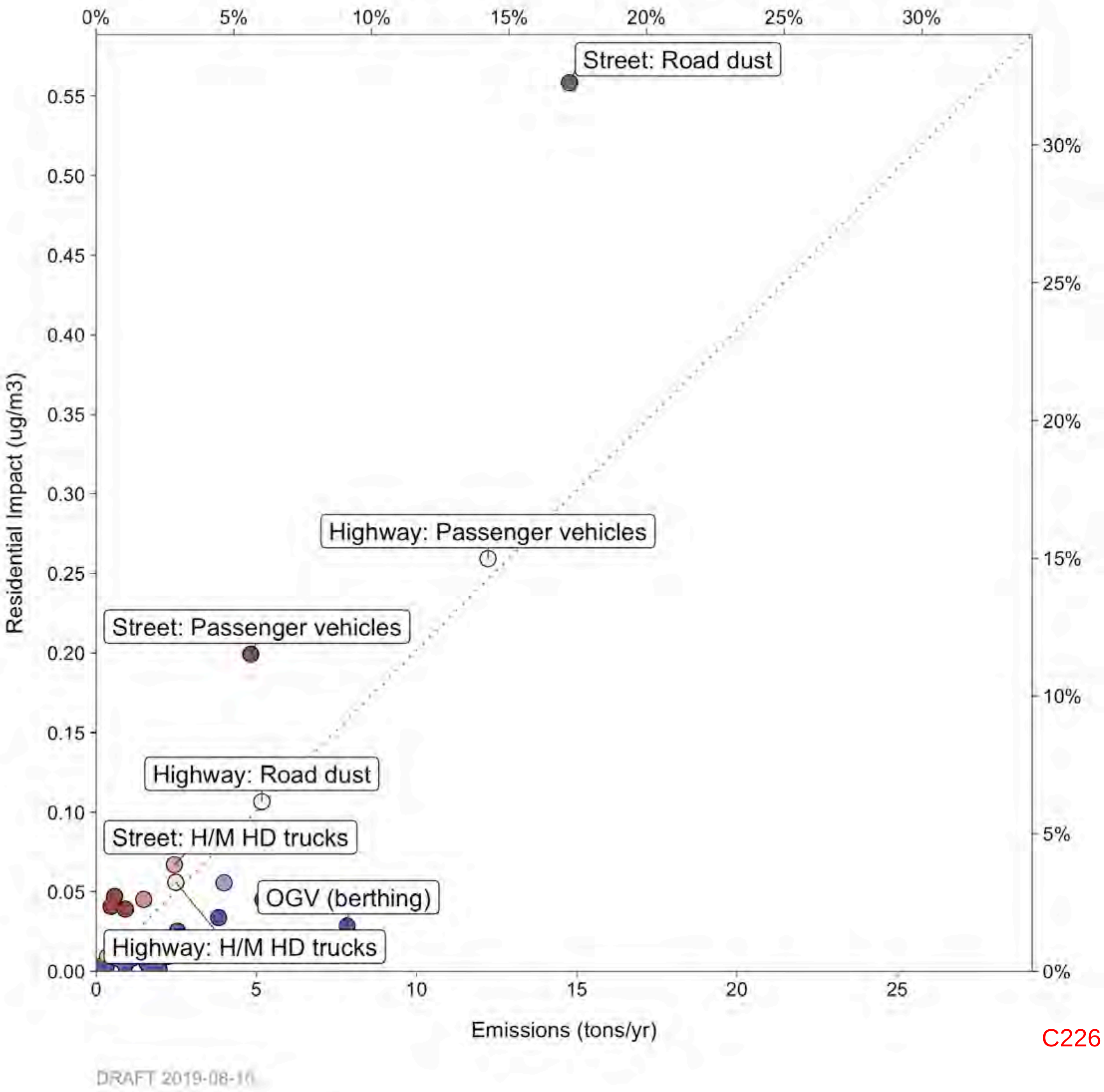
Circles are modeled local sources.
Red is more impact.
Blue is less impact.
Percentages are shares of modeled impact.



C225

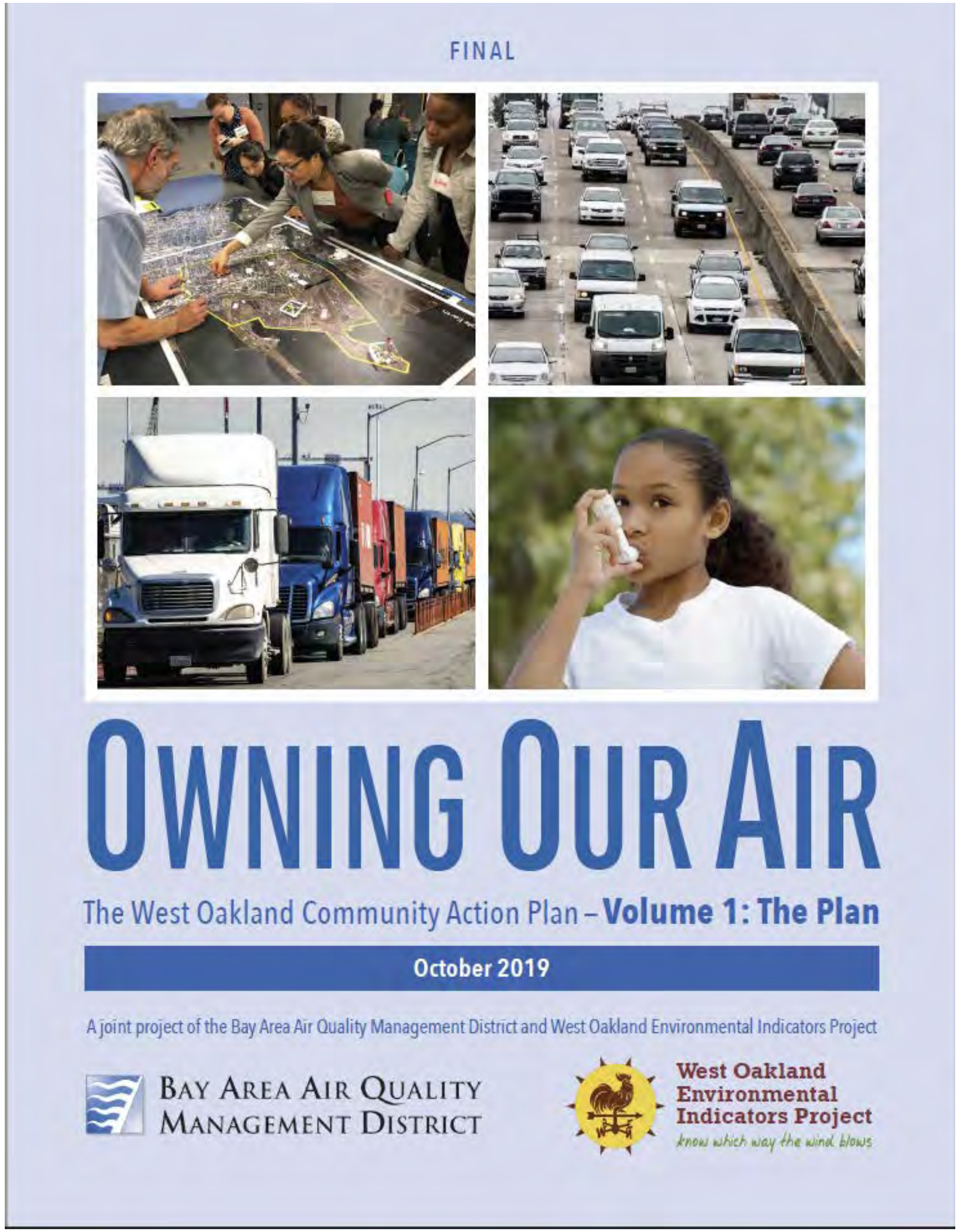
Impact Per Ton: $PM_{2.5}$ in West Oakland

Circles are modeled local sources.
Red is more impact.
Blue is less impact.
Percentages are shares of modeled impact.



More Information

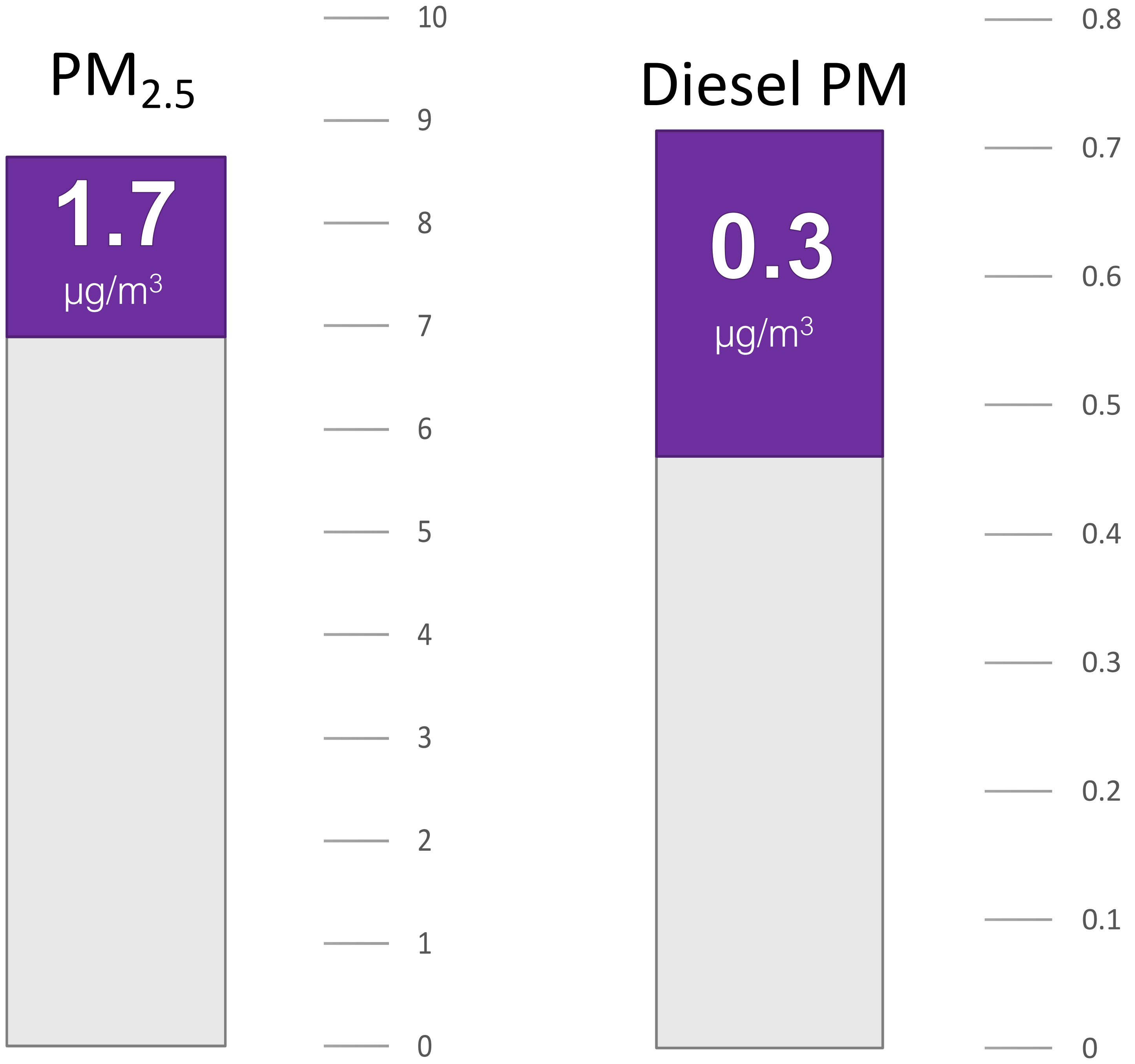
- baaqmd.gov/communityhealth/community-health-protection-program/
- woeip.org/
- arb.ca.gov/ourwork/programs/community-air-protection-program
- pmartien@baaqmd.gov



Extra Slides

How Much is Local?

Local vs. Regional



Local model – mapped impacts*

Regional model (minus West Oakland)

*Construction, residential woodburning, and restaurants not modeled

Thank you

Particulate Matter:
Spotlight on Health Protection

Break




Advisory Council Discussion with Exposure and Risk Panel

Discussion Questions

What are major sources of PM in the Bay Area?

What PM levels exist in Bay Area? What health risks do they pose?

How much additional health benefit can be achieved?

How should we account for spatial scale of effects (i.e., regional versus local-scale impacts, including proximity to major sources)?

How should we determine which measures would most move public health needle?

Advisory Council Deliberation

Particulate Matter:
Spotlight on Health Protection

Particulate Matter:
Spotlight on Health Protection

Adjournment

Particulate Matter:
Spotlight on Health Protection

Particulate Matter:
Spotlight on Health Protection

Advisory Council Meeting Summary: BAAQMD Update on Current and Emerging Efforts on Particulate Matter

December 9, 2019

Bay Area Air Quality Management District

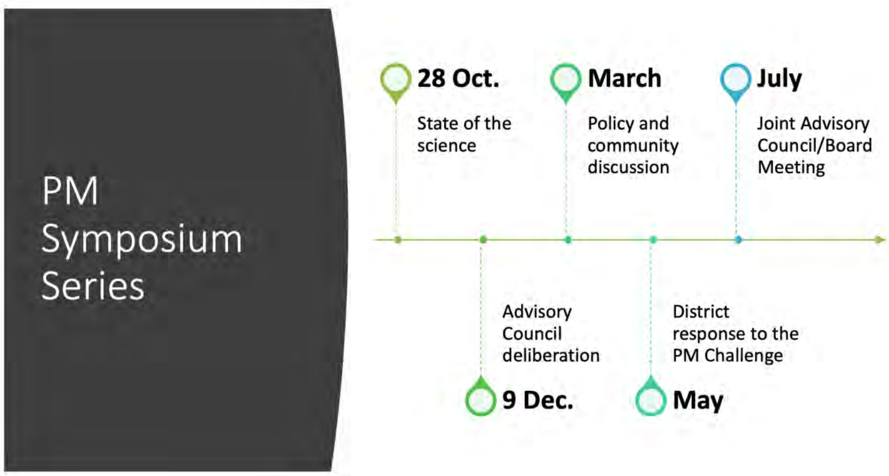
C238

Table of Contents

Executive Summary

The December 9, 2019 meeting of the Advisory Council (Council) of the Bay Area Air Quality Management District (Air District) focused on the Air District's current and emerging work to understand, monitor, reduce, and control regional and localized particulate matter (PM) concentrations.

As the timeline below illustrates, this Advisory Council meeting followed the October PM Symposium, which focused on the state of the science, and preceded the upcoming March PM Symposium. The March PM Symposium will focus on local community work, needs, and priorities. The PM Symposium Series as a whole will inform recommendations from the Advisory Council to the Air District's Board concerning further action the Air District can take to protect the health of Bay Area residents, particularly those who are disproportionately impacted by PM exposure.



[Note: At the time of the presentation, the PM Symposium Series was anticipated to continue through July; however, due to the COVID-19 pandemic and the Bay Area shelter-in-place order, this timeline has changed. Air District staff, together with the Advisory Council and community members, are continuing to discuss particulate matter reduction strategies.]

The December meeting featured presentations regarding local, regional, and state PM reduction initiatives from Air District staff members and a representative from the California Air Resources Board (CARB). Additional agenda items included Advisory Council discussion of a written report on the October PM Symposium; development of a new document by the Advisory Council, which will provide responses to the questions originally posed by the Advisory Council and the Air District to the October PM Symposium panelists; and public comment.

Presentations

Source Apportionment. Phil Martien, Director of Assessment, Inventory, and Modeling, presented the Air District's current knowledge and information gaps regarding the sources of fine particulate matter (PM) in the Bay Area (excluding wildfires). New priorities require the Air District and its partners (CARB, Caltrans) to evaluate and update source apportionment procedures and corresponding regulatory frameworks. As PM emissions from previously dominant sources (such as vehicle emissions) are reduced, additional sources emerge as priorities for controlling PM, yet less information is available about these newly emergent top sources. In particular, models for brake and tire wear and road dust have not been updated since the 1980s. Equally, the Air District's new focus on local-scale exposures requires new approaches to data collection, analysis, and rulemaking regarding stationary-source emissions. Point sources that are not significant at the regional level have not historically been prioritized for monitoring and control. These sources may be significant contributors of $PM_{2.5}$ at the local level.

Monitoring. Ranyee Chiang, Director of Meteorology and Measurements, along with assistant managers Ila Perkins and Katherine Hoag, presented regarding the Air District's monitoring network. They discussed both region-wide monitoring — largely designed to track progress against national ambient air quality standards — and more recently deployed monitoring approaches that are designed to address the Air District's emerging focus on community-scale concentrations or impacts from specific sources of emissions. In response to the Advisory Council's requests, additional information was shared regarding ultrafine particles and wildfires. Ultrafine particle monitoring has been in place for several years but is limited in scope by costs and scientific limitations of the instrument. Wildfires have caused dramatic increases to $PM_{2.5}$ concentration levels in the Bay Area, reversing a decade-long downward trend. The Air District is currently conducting an Integrated PM Network Assessment to evaluate its PM measurement network and recommend improvements.

Grants and Incentives. Karen Schkolnick, Director of Strategic Incentives, presented a summary of the Air District's grant revenue sources, current grants and incentive programs, and recent program results. Because these grant programs generally require emission reductions that go beyond regulatory requirements, the majority of the Air District's grant funding is targeted at reducing $PM_{2.5,}$ other criteria pollutants, air toxics, and greenhouse gases from mobile sources and complementing the Air District's regulatory PM reduction strategies targeting stationary sources. She highlighted several key initiatives focused on reducing mobile-source emissions through adoption of the cleanest commercially available technology (such as Diesel Free by '33 and Port of Oakland partnerships) and discussed how these programs connect to other Air District priorities including health risk reduction in communities disproportionately impacted by air pollution. Since 1991, more than $1.2 billion has been invested through the Air District's grants and incentives programs, resulting in significant emissions reductions and accelerated adoption of cleaner and zero-emission technology. However, each program is constrained by the requirements of its funding source — for example, only one of the Air District's sources of funding can be used to target vehicle miles traveled (VMT) reduction.

CARB PM Research and Rules. Alvaro Alvarado, Manager of Health & Ecosystems Assessment for CARB, described the PM research currently being conducted at CARB and the emerging regulations designed to further decrease PM emissions. In line with the Advisory Council's requests, he focused on research concerning wildfires, brake and tire wear, and ultrafine particles. Wildfire research includes study of a monkey colony at UC Davis, mobile platforms to monitor in-home exposures, and collaboration with NASA to track wildfires using aircraft. Brake and tire wear research includes laboratory studies to quantify emissions as well as exposure studies with UC Riverside and health effects studies with UCLA. Studies of ultrafine particles include modeling annual average concentrations and speciation throughout the state and associating mortality with long-term exposures using the California Teachers Study cohort. With respect to rulemaking, several regulations are underway or forthcoming to reduce emissions from trucks, cars, and trains.

Air District PM Rules and Regulatory Development. Victor Douglas, Manager of Rule Development, presented a brief overview of the history, current efforts, and emerging directions for rule development in the Air District, which continues to update its rules and regulations to further limit PM exposures. As its focus shifts from an exclusively regional perspective to reducing risks for disproportionately impacted local communities, the Air District is exploring further regulation regarding restaurants, wood smoke, and indirect or magnet sources (e.g. warehouses), as well as the possibility of treating PM as a toxic air contaminant. Although the State of California does not presently recognize undifferentiated PM as an air toxic, it may be possible for the Air District to do so independently.

Discussion of Draft October PM Symposium Report

The Advisory Council discussed the draft report on the October PM Symposium prepared by consulting technical writer Elisabeth Andrews on behalf of the Air District, available online at https://www.baaqmd.gov/news-and-events/conferences/pm-conference. Three clarifying edits were made to the section on "Advisory Council Deliberation," and consensus was reached on releasing the draft report for public comment.

Advisory Council Q&A Document

Advisory Council Chair Stan Hayes introduced a document he initiated that provides responses to the questions originally posed by the Advisory Council and the Air District to the October PM Symposium panelists concerning PM health effects, exposures, and risks. His aim was to distill the information shared by the panelists into concise answers to each of the questions. Council Member Gina Solomon volunteered to assist Chair Hayes in further developing the question-and-answer document.

Public Comment

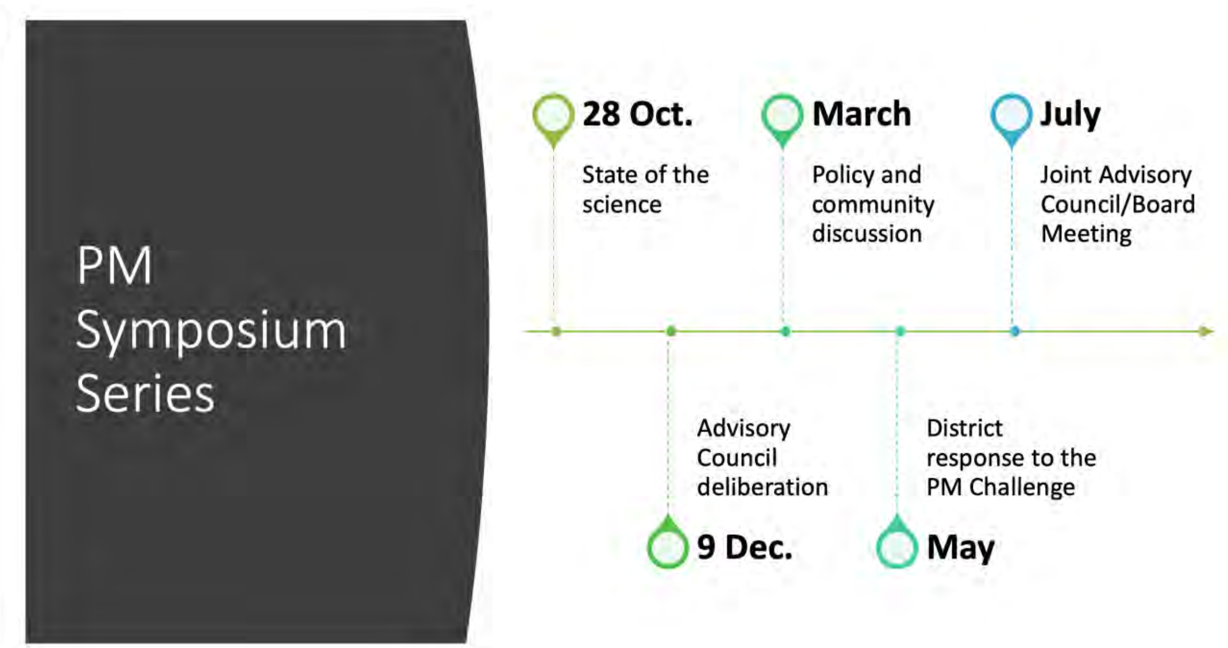
Commenters focused on the urgency of decreasing PM exposures and articulated a need to phase out fossil fuels and transition to a zero-carbon economy. Specific suggestions for the Air District included setting PM threshold levels based on sensitive subgroups rather than population averages, utilizing data from low-cost sensors and the California Household Exposure Study, and developing messaging campaigns focused on demonstrating the connection between specific sources of air pollution and health outcomes.

Next Steps

The next PM symposium will take place on March 24, 2020 in Oakland and is focused on presentations from community organizations and leaders. The May event is expected to focus on formulating potential Air District plans to further reduce Bay Area health risks from PM. The final event in the series brings together the Advisory Council and the Air District's Board of Directors to discuss the information and suggestions shared throughout the PM Symposium Series. During the July meeting, the Advisory Council is expected to present its findings to the Air District's Board of Directors regarding particulate matter and health in the Bay Area.

Background and Timeline

The December 9, 2019 meeting of the Advisory Council (Council) of the Bay Area Air Quality Management District (Air District) followed the October PM Symposium with updates on the Air District's current work on particulate matter (PM). Recognizing that PM is the overwhelming driver of health risks from Bay Area air quality, the Advisory Council requested that the Air District convene the PM Symposium Series in order to clarify the state of the science (October 28, 2019), describe current and forthcoming Air District work (December 9, 2019); learn about local community efforts, needs, and priorities (March 24, 2020); and present potential policy strategies (May 2020). As the timeline below illustrates, the series will culminate in recommendations from the Advisory Council to the Air District's Board of Directors concerning further action the Air District can take to protect the health of Bay Area residents, particularly those who are disproportionately impacted by PM exposure. An additional goal of the Air District and Advisory Council is to provide national leadership on improving air quality at a time when the federal government is retreating from this mission.



[Note: At the time of the presentation, the PM Symposium Series was anticipated to continue through July; however, due to the COVID-19 pandemic and the Bay Area shelter-in-place order, this timeline has changed. Air District staff, together with the Advisory Council and community members, are continuing to discuss particulate matter reduction strategies.]

The first symposium took place on October 28, 2019, convening national, state, and local experts to discuss the state of the science on PM health effects, exposures, and impacts. Details on the presenters and the information they shared can be found in the Draft October PM Symposium Report available at https://www.baaqmd.gov/news-and-events/conferences/pm-conference. Following that event, Chair Hayes presented to the Air District Executive

Committee of the Board of Directors on November 6, 2019 and to its full Board of Directors on November 20, 2019 concerning the Advisory Council's takeaways from the October PM Symposium.

Chair Hayes summarized those presentations at the December meeting. He highlighted several key topics discussed at the October PM Symposium: new evidence of causal relationships between PM and adverse health outcomes including premature death, evidence that the health of children and non-white people are disproportionately harmed by PM, strategies for understanding the sources and distribution of PM, and associations between wildfires and both respiratory and cardiovascular illness. He shared the Sense of the Advisory Council statement that emerged from deliberation at the close of the October PM Symposium:

> The current standards are not adequately health protective.
> Further reductions in PM will realize significant additional health benefits.
> We need more science, *and* we should act now.

Chair Hayes also listed the topics the Advisory Council sought to explore further: approaching PM as an air toxic, expanding monitoring of ultrafine particles, examining health effects of acute PM exposures (e.g. wildfire smoke), identifying PM species that are particularly dangerous, assisting the Air District in identifying strategies with the "highest bang for the buck" in terms of health protection, and pursuing strategies that have climate and other co-benefits.

These priorities set the agenda for the December meeting, which focused on the Air District's current and emerging work to understand, monitor, reduce, and control regional and localized PM concentrations. A representative from the California Air Resources Board (CARB) also presented on state-level PM research and regulations. Additional agenda items included Advisory Council discussion of a written report on the October PM Symposium as well as public comment.

The meeting was shared live via webcast, the video archive of which can be viewed at [http://baha.granicus.com/MediaPlayer.php?clip_id=6369.](http://baha.granicus.com/MediaPlayer.php?clip_id=6369)

Update on Particulate Matter (PM) Air District Work: Regional- and Local-Scale $PM_{2.5}$ Source Apportionment

Phil Martien
Director, Assessment, Inventory, & Modeling, Bay Area Air Quality Management District
Project Lead, Technical Assessment of AB 617 West Oakland Community Action Plan

Main takeaway	**New priorities require the Air District and its partners (CARB, Caltrans) to evaluate and update source apportionment procedures and corresponding regulatory frameworks. As PM emissions from previously dominant sources are reduced, additional sources emerge as priorities for controlling PM, yet less information is available about these newly emergent top sources. This is particularly true for brake and tire wear and re-entrained road dust. Equally, the Air District's new focus on local-scale exposures requires new approaches to data collection, analysis, and rulemaking regarding stationary-source emissions.**

Dr. Martien presented the Air District's current knowledge and information gaps regarding the sources of fine particulate matter in the Bay Area (excluding wildfires). He first described how sources contribute to $PM_{2.5}$ concentration levels at the regional level and then turned to the Air District's community-scale analysis of local sources of $PM_{2.5}$ for West Oakland. The report provided here reflects both the presentation from Dr. Martien and the additional comments and clarifications from other Air District staff members during the presentation.

Current Air District Work

Proportion of regional vs local contributions. Regional sources are the main driver of Bay Area $PM_{2.5}$ concentrations: in West Oakland, local sources appear to contribute about 20% of the overall $PM_{2.5}$ burden in the community. However, time constraints on the West Oakland analysis precluded modeling approximately 30% of local $PM_{2.5}$ sources including construction, residential wood burning, and commercial cooking; these sources may constitute an additional proportion of local contribution to $PM_{2.5}$ concentration levels. Moreover, local sources may have highly significant impacts for people living or working in the immediate vicinity of those sources.

Regional Scale Apportionment

Based on newly updated modeling, peak levels of annual-average $PM_{2.5}$ in the Bay Area are on the order of 10 micrograms per cubic meter ($\mu g/m^3$). In Air District modeling the highest values are seen in the Central Valley. It now appears that **secondary PM formation contributes almost half of $PM_{2.5}$**, which is higher than earlier estimates.

Sources of PRIMARY $PM_{2.5}$ in the Bay Area:

- **Permitted sources (23%)** - Within this category, refineries produce more than 40% of emissions from permitted sources. The top five emitters contribute approximately half of all $PM_{2.5}$ from permitted facilities.
- **On-road mobile sources (27%)** - Within this category, vehicle exhaust now contributes less than 20% of on-road mobile emissions. Brake and tire wear and road dust are far more significant contributors.
- **Non-road mobile sources (16%)** - Within this category, construction activity and commercial marine vessels each account for approximately one third of emissions from non-road mobile sources.
- **Area sources (34%) -** These sources tend to be individually small emitters that collectively make up a large portion of $PM_{2.5}$ emissions, including residential wood combustion and commercial cooking (largely char-broilers).

Sources of SECONDARY $PM_{2.5}$ in the Bay Area:

- **Diesel** trucks and off-road equipment contribute **NO_x**
- **Stationary sources** (including refineries and manufacturing plants) contribute **SO_2**
- **Agricultural activity** contributes **NH_3**

Community Scale Apportionment

Hyperlocal analysis of local-source primary $PM_{2.5}$ emissions was conducted for West Oakland, as described in the report on the October PM Symposium (https://www.baaqmd.gov/news-and-events/conferences/pm-conference) and the West Oakland Community Action Plan. Annual averages of $PM_{2.5}$ concentrations exclusively from local sources were calculated for each census block. $PM_{2.5}$ concentration levels were observed to vary seasonally, across the week, and even hour-by-hour with local activity.

Roadways and permitted facilities. Roadways and permitted facilities emerged as predominant local sources of primary $PM_{2.5}$ in West Oakland (acknowledging again that time constraints precluded modeling construction, residential wood burning, and commercial cooking).

Hyperlocal variation in source apportionment. Predominant sources of local-source $PM_{2.5}$ vary within West Oakland: in its southwest corner, the contributions of port and rail to local-source $PM_{2.5}$ are as high as 25%; roadway contributions in some locations are more than 75%; in other locations stationary sources contribute on the order of 40% of local-source $PM_{2.5}$.

Unequal impacts. Certain census blocks in West Oakland are exposed to much higher levels of local-source $PM_{2.5}$ than others.

Forthcoming Air District Work

The Air District faces challenges in overcoming information gaps concerning newly dominant sources of $PM_{2.5}$. As PM emissions from top sources are reduced, additional sources emerge as priorities, yet less information is available about these other sources. As a result of this lag between re-prioritization and updated scientific literature, there is considerable uncertainty in the estimates of source apportionment, and this uncertainty cannot yet be quantified.

Road dust. As emissions from vehicle exhaust are reduced, the proportion of $PM_{2.5}$ attributed to re-entrained road dust increases. However, calculations for re-entrained road dust were last updated in the late 1980s. These methods are being currently evaluated and updated by CARB and Caltrans.

More analysis of permitted sources. Point sources that are likely significant contributors of $PM_{2.5}$ at the local level may not be significant at the regional level. Because the Air District's focus has historically been at the regional level, direct measurements have not been collected for most of these sources. For example, because West Oakland permitted facilities account for only about 0.5% of emissions in the Bay Area, they have not historically been prioritized for monitoring and control. The Air District's new focus on localized impacts demands greater attention to these sources. For other Bay Area locations, particularly those in which the top five stationary-source emitters are located, the Air District is also in the process of determining local-scale impacts for residents. It is not yet clear how much exposure people experience from these emissions, particularly where emissions are distributed through tall stacks.

Post-Presentation Discussion

Brake and Tire Wear and Road Dust

- Council Member Linda Rudolph inquired about the **climate impacts** of newly emerging $PM_{2.5}$ priorities such as brake and tire wear and road dust. Dr. Martien responded that different $PM_{2.5}$ species can have different climate effects: soot tends to be warming, whereas secondary aerosol can be cooling. Air District Deputy Air Pollution Control Officer Greg Nudd added that road dust tends to be a localized issue as concentrations drop off quickly in spatial terms. However, brake and tire wear have emerged as water quality issues: microplastics in the San Francisco Bay have been shown to originate from tire wear.
- Council Member Severin Borenstein inquired about **technologies to reduce these effects**; Mr. Nudd and Air District Deputy Air Pollution Control Officer Damien Breen responded that reduction in vehicle miles traveled (VMT) is the primary control strategy as few technologies have emerged apart from vacuuming highways and some new European experiments in under-vehicle misting technologies. He later remarked that successful strategies for reducing road dust involve reducing the load on the road; while sweeping can have some positive effect, reducing track-out from construction and limiting roadside contributions through landscaping or paving tend to be more successful.

- Chair Hayes confirmed with Dr. Martien that brake and tire wear and road dust contribute significantly to both local and regional $PM_{2.5}$ exposures and remarked that addressing this issue will be an **important issue for the Air District**.
- Council Member Borenstein inquired about the **relationship between speed, congestion, and $PM_{2.5}$**. Mr. Breen explained that less speed generally means higher exhaust emissions; Dr. Martien stated that dynamometer testing is currently investigating the relationship between speed and brake wear for light- and heavy-duty vehicles.

Air toxics approach. Council Member Michael Kleinman suggested that the greatest benefit to public health may be gained through focusing on the most toxic components of $PM_{2.5}$. He provided the example of lead-contaminated particles from the cement plant in Cupertino posing more of a public health threat than ammonium sulfate aerosols (from secondary $PM_{2.5}$ formation) and stated that many of the secondary aerosols in $PM_{2.5}$ are less toxic than the primary aerosols.

Challenges with commercial cooking and residential wood burning. Council Member Solomon inquired about the Air District's authority with respect to commercial cooking, noting that the categories of regionally significant sources of $PM_{2.5}$ that are within the Air District's jurisdiction appear to make up 43% of the total regional apportionment. Mr. Nudd, with confirmation from Air District Legal Counsel Brian Bunger, explained that the Air District's regulatory authority for commercial cooking is clear. The Air District has an existing rule for large charbroilers. However, available post-combustion controls for restaurant cooking are too large to fit on a restaurant roof and too expensive to preserve profit margins. With respect to reducing residential wood burning, the challenge lies in overcoming cultural barriers.

Update on Particulate Matter (PM) Air District Work: Monitoring

Ranyee Chiang
Director, Meteorology & Measurements, Bay Area Air Quality Management District

Ila Perkins
Assistant Manager, Meteorology & Measurements, Bay Area Air Quality Management District

Katherine Hoag
Assistant Manager, Meteorology & Measurements, Bay Area Air Quality Management District

Main takeaway	**The Air District's new focus on community-scale monitoring complements its ongoing region-wide monitoring efforts. UFP monitoring has been in place for several years but remains limited in scope by costs and scientific limitations of the instruments. Wildfires have caused dramatic increases to $PM_{2.5}$ concentration levels in the Bay Area, reversing a decade-long downward trend.**

Dr. Chiang presented along with two assistant managers in Meteorology & Measurements, Ms. Perkins and Dr. Hoag, on the Air District's current monitoring network. They discussed both region-wide monitoring — largely designed to track progress against national ambient air quality standards — and more recently deployed monitoring approaches that are designed to address the Air District's emerging focus on community-scale concentrations or impacts from specific sources of emissions. In response to the Advisory Council's requests, additional information was shared regarding ultrafine particles and wildfires.

Current Air District Work

<u>Regional/Regulatory Network</u>

The Air District currently has 35 fixed air monitoring stations (as well as 20 meteorology stations) that provide timely air quality data to the public, compare PM concentration levels with national and state standards, inform air quality forecasts for the Spare the Air program, and support research studies. Most sites are selected based on the distribution of the population (2010 Census) and the concentration of pollutants, with some additional sites placed downwind of major pollution sources, to describe regional transport of pollutants, or in areas representing general background PM levels.

The measurement instrumentation used for Air District PM monitoring is described in Table 1. Mass measurements support compliance with California and national PM_{10} and $PM_{2.5}$ health-based standards and designate which areas are in attainment or nonattainment; chemically resolved or speciated data measurements support emission reduction strategies; and particle counts of smaller particle sizes support science on emissions, air quality impacts, and health effects of types of PM for which there is currently no health-based standard.

Table 1 - Air District PM Instrumentation

Measurement Type	Mass		Chemically resolved or speciated		Particle count
Measurement application	Compliance with standards; Designate areas as attainment or nonattainment		Support emission reduction strategies		Assess air quality impacts and exposures
Analytical Target	PM_{10} mass	$PM_{2.5}$ mass	Black carbon	$PM_{2.5}$ speciation	Ultrafine particles ($PM_{0.1}$)
Analytical Methods	Gravimetric	Gravimetric or Filter-based beta attenuation	Filter-based light attenuation	Chemical extraction	Laser-based
Number of Active Monitors	7	20	7	4	6

Ultrafine Particle Monitoring

Strengths. The Air District has conducted ultrafine particle monitoring for more than seven years in a range of sites, producing data that can be used to understand diurnal and seasonal patterns and trends as well as differences between background, near-road, and typical urban settings.

Limitations. Ultrafine particle instrumentation is costly ($60,000-$100,000 per unit), requires frequent maintenance in PM-burdened areas, and cannot presently support identification of sources and sinks or robust links to specific health impacts.

Results. Air District ultrafine particle monitors installed in a variety of locations reveal that UFP concentrations reflect fresh, primary particulate emissions from both combustion and secondary formation. Higher levels of ultrafine particles are seen in near-road environments, with peaks at high-commute hours and the middle of the day, indicating a photochemical signature.

Wildfires

Prior to 2017, occasional impacts from wildfires did not have a significant influence on year-to-year trends, yet recent wildfires have dramatically affected Bay Area $PM_{2.5}$ concentration levels. Figure 1 shows the overwhelming effect of wildfires in 2017 and 2018. With wildfire days removed, there has been a downward trend in $PM_{2.5}$ concentration levels for the past decade, yet wildfires have caused a sharp reversal of that trend, resulting in the Bay Area substantially exceeding the 24-hour federal standard for 2016 – 2018.

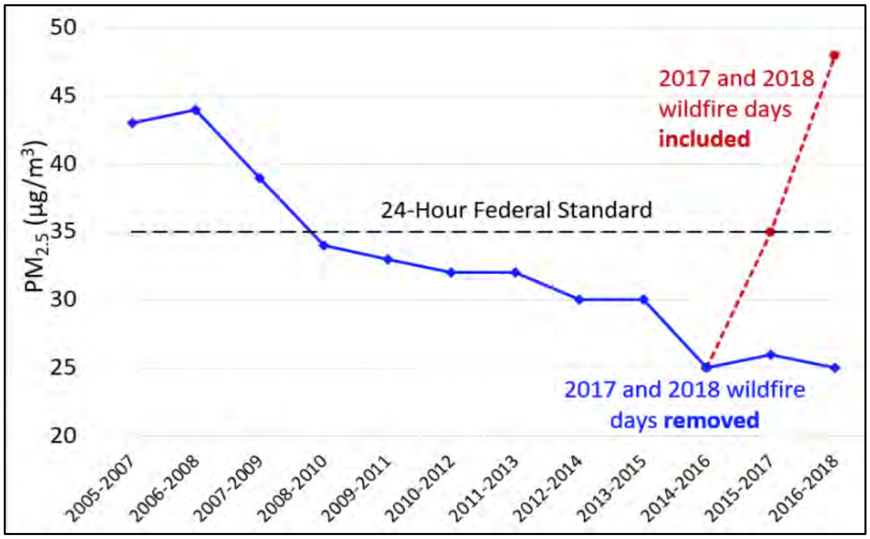


Figure 1 - Wildfire impact on 24-hour $PM_{2.5}$ concentration levels

Air District initiatives to minimize exposure to wildfire PM include:

- Communicating with the public about reducing personal exposure
- Collaborating with public health officers and other agencies to ensure consistent messaging
- Funding Clean Air Centers in which vulnerable people can seek refuge
- Offering grants and incentives for recovery assistance
- Providing guidance for local organizations, particularly schools

Forthcoming Air District Work

Community-Scale Monitoring

Several new developments support the Air District's new focus on community-scale monitoring:

Hyperlocal monitoring
In partnership with Aclima, the Air District is conducting street-by-street monitoring using vehicle-mounted sensor-based instrumentation measuring NO_x, CO, O_3, and $PM_{2.5}$, similar to previous studies Aclima performed in West Oakland and other areas. Measurements for a short-term study in the AB 617 Richmond-San Pablo study area will soon be available, and the Air District aims to use this technology to map average baseline hyperlocal air quality for the entire Bay Area within two years.

Mobile Laboratories

The Air District is also developing a van with mobile monitoring capabilities that can perform high-accuracy, detailed mobile or short-term measurements of PM and many specific gaseous air toxics, including the amount of PM of different sizes. Potential uses of this new monitoring van include supporting localized source apportionment and prioritization, confirming and improving the understanding of air quality issues identified by the AB 617 Steering Committees, and identifying locations for further fixed-site or portable monitoring.

Portable platforms

Highly portable, suitcase-sized monitoring systems will also be developed for battery-powered, continuous, real-time PM measurements. Although these technologies are expensive, they could enable measurements during power outages, which is important for supplying real-time air quality data during wildfires and periods of heightened wildfire hazard. These instruments can also be used to verify data from lower-cost sensor networks (such as PurpleAir).

Combining Monitoring Strategies

Whereas the regional fixed site network is primarily focused on large-scale assessments and long-term trends, the special projects and sensor networks described in Table 2 enable more community-specific assessment. The Air District's engagement in sensor networks involves working closely with community organizations and companies to provide technical capacity building and advice regarding the advantages, limitations, and uncertainties of different technologies.

Table 2 – Air District PM Monitoring Strategies and Objectives

Network	Measurements	Objectives	Limitations
Regional Network	$PM_{2.5}$ and PM_{10} mass	-Comparison with standards -Public information -Track long-term trends -Assess out-of-area transport	-High cost -Information gaps at community scale
Special projects: -fixed site -mobile laboratory -portable platforms	-PM size distribution -PM speciation -Ultrafine particles -Black carbon	-Source identification -Assessment of specific emission sources -Characterization of near-road environments	-High cost
Sensor networks: -fixed site -mobile/portable	-PM mass -Particle count	-Public education -Personal exposure monitoring -Identification of hot spots -Comparative assessment of local air quality -Tracking high-PM episodes	-Higher level of uncertainty

To strengthen these approaches, the Air District will complete an **Integrated PM Network Assessment by July 2020** to evaluate its PM measurement network and recommend improvements. The assessment aims to determine how available resources and multiple monitoring approaches can best be deployed not only to continue addressing federal and state requirements but also to support and expand community-scale air monitoring activities and other Air District programs.

Post-Presentation Discussion

Ultrafine Particles

- **Monitoring costs.** Council Member Solomon inquired whether ultrafine particles monitoring equipment costs are expected to drop in the foreseeable future. Ms. Perkins replied that the Air District relies on one primary manufacturer and does not anticipate near-term cost reductions. Council Member Solomon introduced the idea of a challenge to technology developers to accelerate innovation in the direction of affordability. Dr. Chiang responded that she would contact representatives from the Environmental Protection Agency and CARB to investigate the possibility of pooling resources to propose such an initiative.
- **Data application.** Council Member Rudolph asked how the Air District's ultrafine particle data is being used to improve public health. Dr. Hoag responded that the data adds to the imperative to reduce roadway emissions. Mr. Nudd added that the Air District is implementing project grants to install filtration in near-roadway schools and is advising the Plan Bay Area initiative on limiting near-roadway exposures.
- **"We need more science, and we should act."** Chair Hayes reiterated the message from the first PM Symposium that while it is clear that more science is needed on UFP — including a federal reference method standardizing ultrafine particle measurement and epidemiological studies linking exposures to health effects — the Air District should also take immediate action.
- **Near-road health effects.** Following clarifications from Air District staff that the high levels of monitored UFP were due to roadway proximity, Council Member Kleinman pointed out that the documented health effects of near-road environments include low birth weight and cardiovascular problems. While there are many challenges for ultrafine particle research, including the difficulty of assessing dosage due to the extraordinarily low mass of UFP, studying the health effects of near-road environments may be an effective approach to understanding UFP exposures. He added that ultrafine particle concentrations drop precipitously as the distance from the roadway increases, with particle counts dropping by 80% at a 100-meter distance from the center of the road (and an additional 80% at a further 100 meters). Therefore, zoning regulations, berms, and buffers can make a significant difference in limiting exposures.
- **Combustion as source of UFP.** Dr. Hoag clarified in response to Council Member Borenstein's question about brake and tire wear and road dust that the source of UFP is combustion, not vehicle wear or road dust. She further clarified in response to Council Member Tim Lipman's question about ultrafine particle precursors that the sources of UFP appear to be anthropogenic.

- **Stationary sources and UFP.** Council Member Solomon asked whether the Air District has investigated UFP emissions from stationary sources. Dr. Hoag responded that such analysis has not been conducted, in part because UFP concentrations are unlikely to remain high outside the perimeter of the facilities due to the distance-based decreases in particle counts described above. However, she stated that this type of measurement could be a possible application for the new mobile and portable monitoring technologies.
- **UFP gradient studies in the Bay Area.** Council Member Solomon asked whether the Air District is conducting studies to assess the persistence of UFP concentrations at increasing distances from Bay Area roadways. Dr. Hoag replied that this analysis had not been undertaken as part of UFP monitoring in the Bay Area but that many previous studies had established the patterns of near-roadway UFP distribution, including the influence of meteorology, topography, and roadway design.

Data sharing. Council Member Rudolph also asked for clarification on how data is being shared with the public. Mr. Breen stated that regional network monitoring data is available on the Air District website (http://www.baaqmd.gov/about-air-quality/current-air-quality). Dr. Hoag added that the community-scale data being collected by Aclima will also be publicly available once it has undergone quality assurance.

Update on Particulate Matter (PM) Air District Work: Grants and Incentives

Karen Schkolnick
Director, Strategic Incentives, Bay Area Air Quality Management District

Main takeaway	**Since 1991, more than $1.2 billion has been invested through the Air District's grants and incentives programs, resulting in significant emissions reductions and accelerated adoption of cleaner and zero-emission technology. Because these initiatives are not subject to regulatory constraints, the Air District is able to use the great majority of funds to target mobile sources. However, programs are constrained by the requirements of the funder — for example, there is only one source of funding that can be used for VMT reduction.**

Ms. Schkolnick presented a summary of the Air District's grant revenue sources, current grants and incentive programs, and recent program results. She highlighted several key initiatives that incentivize the accelerated adoption of the cleanest commercially available technology and discussed how these programs connect to other Air District priorities including health risk reduction in communities disproportionately impacted by air pollution.

Current Air District Work

<u>Prioritization Process</u>

Because grants and incentive programs are not tied to regulatory constraints, the Air District is able focus almost all of its funding through these programs (90 to 95%) on reducing mobile-source emissions. Most of this funding goes toward accelerating the adoption of the cleanest commercially available technology. An additional priority is expediting emissions reductions in disproportionately impacted communities.

The cost effectiveness (CE) of nearly all programs is evaluated using the following formula (or a variant) from the Carl Moyer Program, established by the State of California and CARB:

$$CE = \frac{Funds\ Awarded}{Tons\ of\ NOx + ROG + (\boldsymbol{PM_{10}\ x\ 20})\ reduced}$$

Notably, this formula has changed over 20 years by incrementally increasing the weighting of PM from 1 to 20, reflecting the State's interest in health protection.

Current Funding Allocation

$97 million from grants and incentives in 2018 were allocated to:

- **On-road emissions reduction — $32 million (one third),** supporting both deployment and infrastructure for lower- or zero-emission light-, medium-, and heavy-duty vehicles (cars, trucks, and buses). Notably, pass-through programs also support this category, so the total amount of support is higher than this number.
- **Off-road mobile source emissions — $44.4 million (almost half),** from sources such as cargo handling equipment, agricultural equipment, marine and locomotive vehicles, and airport ground support. These are primarily diesel emissions and the cleanest commercially available technology in most cases is cleaner diesel, transitioning from Tier 0 or 1 to Tier 4 engines, although some electrification is now occurring such as Caltrain and lighter cargo handling and air ground-support equipment.
- **Vehicle Miles Traveled (VMT) reduction — $6.2 million (plus nearly $9 million in pass-through),** including shuttle and ride-share services connecting to mass transit, pilot services such as Bay Area Bike Share (now sponsored by Lyft), and expansion of bikeways and bike parking. The Spare the Air program is also funded in this category. For the Spare the Air program, funding is also supplied through pass-through programs, so the total amount of support is higher.
- **Household technology and local climate action — $5.1 million,** including lawn and garden equipment replacement, wood smoke reduction (now focused on reducing combustion through transition to heat pumps), and capacity-building for schools and local government.
- **Pass-through to county transportation agencies — $9.5 million,** primarily to implement trip reduction and on-road vehicle emissions reduction.

Notable Initiatives

Diesel Free by '33

This program focuses on introducing zero-emission technology in each category of vehicles and equipment as soon as it becomes commercially available. While the present focus is on the light-duty sector, the program is designed to incorporate categories such as marine, locomotive, and construction vehicles and equipment as technology evolves.

The **light-duty sector** demonstrates the expected pattern: While hybrid and natural gas vehicles were the best available technology 10 years ago, zero-emission vehicles have since emerged and become a focus for Air District grants and incentives funding. Currently:

- More than $15 million has been invested by the Air District, plus additional investments from the federal and state government and the private sector to help accelerate the adoption of light-duty zero-emissions vehicles
- Almost 8,000 electric vehicle charging ports are in place

- Renewables are included in 25% of Air District-supported charging ports
- Low-income residents are a focus for vehicle electrification programs
- 3% of Bay Area vehicles are electric
- 25% of all electric vehicles in the U.S. are in the Bay Area
- Goal: Five million vehicles by 2050
    - Presently ahead of schedule
    - Limitation is availability of vehicles

R&D advanced technology demonstration programs

The Air District also participates in advanced demonstration programs, which provide proof-of-concept for the deployment of improved technologies that are not yet commercially available. The Air District has recently been serving as the lead administrator for a $2.9 million project in partnership with Goodwill Industries, BYD (a manufacturer of heavy-duty battery electric vehicles and equipment) and CARB. This project will test and deploy 10 electric delivery trucks and one refuse hauler. Another $3 million project in partnership with Golden Gate Zero Emissions Marine and CARB will build, test, and deploy the first hydrogen-powered ferry for passenger service in mid-2020. Both of these projects are funded primarily through the California Climate Investments program from CARB's Low Carbon Transportation program.

Port of Oakland

Over the course of ten years, Air District grants have invested approximately $120 million in retrofitting and replacing vehicle technology and infrastructure at the Port of Oakland, including replacing approximately 2,000 drayage trucks and more than 1,000 on-road trucks, installing shore power at 14 berths, and updating harbor craft and cargo handling equipment.

Recent (since 2015) Results and Highlights

Significant reductions in regionwide emissions

- CO_2: nearly 600K tons
- NO_x: more than 3K tons
- Reactive organic gas: more than 1K tons
- PM_{10}: nearly 400 tons

Infrastructure and equipment implemented

- More than 1,000 electric vehicle charging stations
- Approximately 40 miles of bikeways
- More than 1,200 woodstoves and fireplaces replaced
- More than 100 zero-emissions transit and school buses

Supporting disproportionately impacted communities

Approximately 53% of funds went to programs in Community Air Risk Evaluation (CARE) areas.

More than $1.2 billion in total investments

Through 2020, clean air investments from Air District grants and incentives total over $1.2 billion. This figure represents significant growth since these programs were initiated in 1991 with approximately $5 million.

Forthcoming Air District Work

For 2020, an estimated $108 million will be invested through the Air District's Strategic Incentives programs. In addition to the continuation of the initiatives described above, including the expansion of eligible vehicles and equipment for Diesel Free by '33, the Air District will promote:

- expansion of **lawn and garden** equipment replacement programs,
- reducing **motorcycle** usage,
- funding **air filtration systems** and **clean air shelters**,
- funding **climate resilience** programs, and
- securing **new sources of funding** to expand eligibility of existing programs (such as VMT reduction) and initiate new efforts.

Post-Presentation Discussion

Successes. Chair Hayes and Council Member Rudolph commended the Air District's successes through its grants and incentives programs, particularly with regard to the Port of Oakland and other initiatives targeting diesel particulate matter.

VMT reduction. Council Member Rudolph asked why more funding had not been allocated to VMT reduction and inquired whether the Carl Moyer formula disincentivized VMT as a focus. Ms. Schkolnick explained that while VMT reduction is a priority for the Air District, efforts are limited by available funding sources. The only funding stream that allows for VMT reduction is the Transportation Fund for Clean Air. Annually, of that fund's approximately $25 million, $9 million is allocated as a pass-through to county transportation agencies and used primarily for VMT reduction. The Air District's remaining amount from that fund is split between light-duty emission reduction programs and reducing VMT. Additionally, the Air District partners with the Metropolitan Transportation Commission on regional efforts such as the Bay Area Carpool Program through 511.org and Spare the Air. Mr. Breen added that the new focus on VMT and reducing brake and tire wear and road dust comes as a result of the Air District's successes in reducing emissions from diesel particulate matter, which was previously the predominant source of PM and remains a significant health concern in disproportionately impacted communities. He noted that the science has not yet caught up to the change in priorities, and that the Air District can advocate for changes in legislation once that science is clear.

Retirement of diesel equipment. Council Member Lipman inquired whether the Diesel Free by '33 initiative is retiring diesel vehicles and equipment or only adding additional lower- and zero-emissions technologies to fleets. Ms. Schkolnick clarified that nearly all Diesel Free by '33 programs are replacement programs.

Evaluation formula. Chair Hayes asked for clarification on the use of the Carl Moyer guidelines for evaluating cost effectiveness. In response to Chair Hayes' question concerning the designation of PM_{10} as the focus of emissions reduction, Ms. Schkolnick affirmed that the formula does specify PM_{10} rather than $PM_{2.5}$. She added that there has been some discussion about converting the formula to $PM_{2.5}$, but it is not clear how the formula would need to be altered to result in an equivalent evaluation. She also clarified in response to Chair Hayes' question about sidebar calculations that the Air District does use additional and more complex calculations to further evaluate some programs, such as co-benefits, $PM_{2.5}$, brake and tire wear and road dust, and proximity to disproportionately impacted communities. Council Member Kleinman commented that the risk of specifying PM_{10} is that courser particles are easiest to remove and, due to their greater mass, will reflect a greater apparent reduction of emissions while potentially leaving in place all the $PM_{2.5}$. He noted that to ensure health protection it would be beneficial to apply an alternative formula that balances that risk. Mr. Breen clarified that while the Carl Moyer Program requires the application of the specified formula, the tools that the Air District uses (such as calculating Significant Emissions Rates and using diesel particulate matter filters) do capture $PM_{2.5}$. He acknowledged that the more difficult correlation to establish is the degree to which applying the Carl Moyer guidelines using Air District approaches succeeds in reducing ultrafine PM.

Renewable charging stations. Council Member Kleinman asked how many of the approximately 8,000 electrical vehicle charging stations use renewable energy. Ms. Schkolnick replied that while she did not have information about all of the charging stations in the area, approximately 25% of the stations that the Air District has funded use renewable energy (primary solar).

Update on Particulate Matter (PM) Work: CARB PM Research and Rules

Alvaro Alvarado
Manager, Health & Ecosystems Assessment, California Air Resources Board (CARB)

Main takeaway	**CARB is currently conducting research to better understand the air quality impact of wildfires, brake and tire wear, and ultrafine particles. New and forthcoming regulations will soon be implemented to further reduce emissions from mobile sources.**

Dr. Alvarado described the PM research currently being conducted at the California Air Resources Board and the emerging regulations designed to further decrease PM emissions. In line with the Advisory Council's requests, he focused on research concerning wildfires, brake and tire wear, and ultrafine particles. Several regulations are underway or forthcoming regarding trucks, cars, and trains.

Current CARB Research

Why PM? Dr. Alvarado began his presentation by highlighting the health impacts of PM including approximately 7,200 premature deaths each year in California. Although CARB regulations specifically track hospitalizations and emergency room visits as health outcomes of PM, CARB is also aware of and concerned with outcomes such as asthma attacks and other respiratory symptoms, adverse brain effects, and work loss days. He noted that regulations implemented over the past 25 years, particularly with respect to trucks, have contributed to substantial decreases in average $PM_{2.5}$ concentrations.

<u>Wildfires</u>

Millions of Californians — by some estimates, the entire State population — were exposed to wildfire smoke in 2018, and wildfires are expected to become more frequent and widespread as a result of climate change. Although the current assumption is that all PM is equally toxic, this may not be the case; as wildfires cause more extensive damage there will be more combustion of structures and vehicles that could cause more toxic smoke. Effects could be particularly pronounced for children and older adults. Current CARB research includes:

- **Monkey study at UC Davis.** As Office of Environmental Health Hazard (OEHHA) Director Lauren Zeise described during the first Air District PM symposium, UC Davis researchers are investigating the effects of the 2008 wildfires on an outdoor captive monkey colony. When compared to monkeys in the population born in 2009, monkeys that were infants in 2008 experienced impaired immune function, changes in lung structure, and reduced lung function, which persisted into adulthood. Moreover, immune effects were passed on to the next generation.

- **Wildfire emissions research.** Researchers at UC Berkeley and UC Riverside are using mobile monitoring platforms to investigate in-home exposures to wildfire smoke, and CARB is partnering with NASA to use aircraft to collect wildfire data.

Brake and Tire Wear

As previously noted by other presenters, as tailpipe emissions are reduced, brake and tire wear become more predominant sources of mobile-source PM. These emissions are more localized; whereas tailpipe emissions are associated with secondary PM and downwind exposures, brake and tire wear primarily affect people living near roadways. Health effects from brake and tire wear may be distinct from tailpipe emissions due to the presence of metals and plastics in wear-based PM emissions. Current CARB research includes:

- **Laboratory studies** quantifying brake and tire wear emissions using dynamometers,
- **Community exposure** studies with UC Riverside, and
- **Health effects** studies with UCLA.

Ultrafine Particles

Dr. Alvarado reiterated that ultrafine particles are difficult to measure and study, that it travels from the lungs to other organs including the brain, and that concentrations vary by space and time with peaks near roadways and during traffic that taper off at a distance and at night. He noted that prior research, primarily in Europe, has limited utility as it tends to focus on short-term exposures (one to four days) measured at only one location and using the extreme outcomes of hospitalizations and premature death. If ultrafine particles are similar to $PM_{2.5}$, long-term exposures can be expected to be far more significant than short-term exposures and indexed to population proximity and vulnerability.

To begin closing these research gaps, current CARB research is 1) **modeling ultrafine particles** annual average concentrations and speciation throughout the state and 2) **associating mortality** with long-term exposures using the California Teachers Study cohort. Preliminary results suggest an increased risk of premature death with high exposure to ultrafine particles. Additionally, to better understand health effects of short-term exposures to UFP, CARB is working with Council Member Kleinman to identify gaps in available research and develop a research plan.

Forthcoming CARB Regulations

A number of regulations will soon be implemented to further reduce mobile source emissions.

Heavy-Duty Trucks

- Advanced Clean Truck Regulation will transition heavy-duty trucks to zero emissions starting in 2024.
- Heavy-duty vehicle inspection and maintenance will require trucks to pass an inspection similar to a smog check in order to register with the California Department of Motor Vehicles.
- Innovative Clean Transit will transition public transit buses to zero emissions.
- Airport shuttles will also be transitioned to zero-emission vehicles by 2035.
- The Heavy-Duty Low NO_x omnibus rule will reduce NO_x as well as PM from diesel trucks, thereby addressing both primary and secondary PM.

Warehouses

- CARB is developing a Freight Handbook outlining best practices for warehouses to reduce their contributions to emission levels.
- New regulations are being developed for:
  - Transport refrigeration units,
  - Drayage trucks, and
  - Cargo handling equipment.

Passenger Cars

- Advanced Clean Cars 2 will increase the number of zero-emission vehicles on the road and reduce tailpipe emission through 2026.
- Catalytic converter theft reduction is being implemented to ensure that converters are stamped by manufacturers and registered with cars.

Trains

CARB is currently working with railyards in southern California to reduce idling. Lessons from this effort will be applied statewide, potentially through regulation, to reduce emissions from trains.

Post-Presentation Discussion

Next steps? Chair Hayes asked for the presenter's opinion on the next steps to improve public health. Dr. Alvarado, who clarified that he was speaking on behalf of himself and not CARB, replied that his priority would be to utilize low-cost in-home monitors to better understand how short-term localized exposures are affecting people in disadvantaged communities. This information could be used to direct regulations and resources toward improving health among the most vulnerable Californians, in line with AB 617.

Addressing brake and tire wear and road dust. Noting that Dr. Martien's presentation revealed that the great majority of PM emissions experienced in West Oakland are from regional sources, Chair Hayes inquired whether brake and tire wear and road dust contribute to these regional-source exposures and whether these issues are under CARB's regulatory authority. Dr. Alvarado replied that he could not speak to CARB's authority on these matters, but that brake and tire wear and road dust are more localized issues. Council Member Kleinman commented that regenerative braking technology appears to reduce brake wear and could be a useful target for incentive structures. Council Member Lipman clarified that such technology can only be used with hybrid vehicles, but that it could be promising as an innovation that benefits both fuel efficiency and PM reduction.

Relative health impact of wildfires. Chair Hayes asked the presenter to characterize the relative contribution of wildfires to public health risk in comparison to day-to-day PM emissions from other sources. Dr. Alvarado responded that while there was not sufficient research to quantify the impact of wildfires at their newly intensified levels, it does appear that wildfire smoke has health effects similar to those of other types of PM exposure.

Defining premature death. Council Member Lipman asked for clarification on how premature death is defined in CARB's calculations. Dr. Alvarado, along with Council Members Kleinman and Rudolph, clarified that the calculation is a statistical analysis of population-level loss of life relative to life expectancy.

New technologies increasing UFP? Council Member Solomon recalled that when natural gas and diesel reduction technologies were first being developed for transportation, there was some concern that they could increase ultrafine particle emissions. She asked whether that prediction had been accurate. Dr. Alvarado responded that while he would need to check to be certain, he believed that an initial increase in ultrafine particles was seen in early natural gas vehicles, but the problem had since been addressed through controls.

Update on Particulate Matter (PM) Air District Work: PM Rules and Regulatory Development

Victor Douglas
Manager, Rule Development, Bay Area Air Quality Management District

Main takeaway	**The Air District continues to update its rules and regulations to further limit PM exposures. As its focus shifts from an exclusively regional perspective to reducing risks for disproportionately impacted local communities, the Air District is exploring the possibility of treating PM as a toxic air contaminant. Although the State of California does not presently recognize undifferentiated PM as an air toxic, it may be possible for the Air District to do so independently.**

Mr. Douglas presented a brief overview of the history, current efforts, and emerging directions for rule development in the Air District. He described how the Air District's emerging focus on health risks for local communities is prompting further consideration of rulemaking regarding stationary source emissions and potential treatment of undifferentiated PM as an air toxic.

Current Air District Work

Approaches

The Air District has approached PM regulation in three distinct ways:

1. As a **nuisance**, which was the initial approach in the first Air District regulations adopted in 1979 and 1980 regarding open burning and dust and aerosols.
2. As a **criteria pollutant**, which is the current, regional approach to undifferentiated PM governing attainment of ambient air quality standards. These regulations apply to both primary PM (filterable and condensable) and precursors of secondary PM (oxides of nitrogen and sulfur dioxide). With this approach, the Air District selects the most cost-effective strategies to achieve regional standards.
3. As an **air toxic**, which is the approach taken specifically to diesel PM to limit localized exposures. The air toxic approach can be either risk-based (utilizing modeling) or technology-based (limiting emissions from specific sources, such as dry-cleaning facilities or backup generators).

Mr. Douglas mentioned that a fourth potential approach would be to consider climate impacts.

Regulations and Rules

There are 57 Air District rules that directly or indirectly address PM, housed within a range of regulations including those governing permits, open burning, inorganic gaseous pollutants, hazardous pollutants, and miscellaneous standards of performance. Several PM regulations and rules have been updated since 2012, including a new Regulation 6 on Particulate Matter established in 2018.

Mr. Douglas specifically highlighted **Air District Rule 11-18: Reduction of risk from air toxic emissions at existing facilities.** Recent revisions to this rule reduced the threshold limit on toxic air contaminants by an order of magnitude (from 100 per million to 10 per million), requiring approximately 80 existing permitted facilities to develop plans to reduce their emissions or install best available control technologies. This rule is one example of the Air District's emerging focus on localized, community-specific exposures and health risk. Another example he mentioned is **Rule 6-5: Particulate emissions from refinery fluidized catalytic cracking units**, which was recently revised to further reduce localized PM emissions from refineries.

Forthcoming Air District Work

Localized Sources

As the Air District turns increasing attention to localized health impacts of PM for disproportionately impacted communities, it is exploring further regulation regarding:

- **Restaurants**,
- **Wood smoke**, and
- **Indirect or magnet sources** (e.g. warehouses, which do not directly emit PM, but attract PM-producing traffic such as diesel trucks).

PM as an Air Toxic

The Air District is also engaged in exploring the possibility of approaching undifferentiated PM as an air toxic. The present constraint is that the Air District has relied on the State of California's list of toxic air contaminants, which does not include undifferentiated PM. Air District rulemaking that treats PM as a toxic could potentially be developed, independent of state-level air toxics regulations, if the Air District is able to identify appropriate methodology to perform health risk assessments.

Post-Presentation Discussion

Shifting focus to greenhouse gas emissions and global warming? Council Member Rudolph asked how a hypothetical emphasis on climate impacts would shift the Air District's approach to PM regulation. Mr. Douglas responded that reducing climate impacts is a co-benefit of the other three approaches to PM (as a nuisance, criteria pollutant, and air toxic). Mr. Nudd added that an emphasis on climate impacts could shift the Air District's focus more heavily toward black carbon, but that he was uncertain of the effect such a shift would have on health risks.

Council Member Rudolph commented that climate change presents the greatest health risk to the population.

Toxics framework. Chair Hayes asked for clarification on the process by which undifferentiated PM could be introduced into the regulatory framework as a toxic air contaminant. Mr. Bunger explained that the first option was for OEHHA to add undifferentiated PM to its list of air toxics, which would immediately trigger its inclusion in several existing Air District rules including 11-18 (existing facilities) and 2-5 (new source review). The Air District has requested this action from OEHHA, and analysis is underway at the state level, but the Air District does not have the power to compel such action by the State. However, in theory, the Air District does have the ability to independently classify undifferentiated PM as a toxic air contaminant and treat it accordingly. To do so, the Air District would need to identify appropriate methodology to use for health risk assessment. Chair Hayes noted that the Air District already concerns itself with controlling source-specific PM emissions in its modeling regarding attainment of ambient air quality standards. Mr. Bunger clarified that such analysis does not presently apply to every source of PM emissions, as it would if PM were classified as an air toxic. Board Member Sinks asked whether OEHHA has committed to a schedule for evaluating undifferentiated PM for potential inclusion on its air toxics list. Mr. Nudd responded that he does not observe a willingness on the part of OEHHA to enact statewide recognition of undifferentiated PM as an air toxic in the near term, likely due to present challenges in some parts of the state with meeting existing federal air quality standards. However, he explained that OEHHA is assisting the Air District with its PM analyses, and does appear willing to support the Air District (at least through peer review) if it moves toward independently recognizing undifferentiated PM as a toxic. Mr. Bunger noted that the Air District is also exploring other distinct PM species (besides diesel PM) as air toxics.

Discussion of Draft October PM Symposium Report and Advisory Council Q&A Document

The Advisory Council discussed the draft report on the October PM Symposium prepared by consulting technical writer Elisabeth Andrews on behalf of the Air District, available online at https://www.baaqmd.gov/news-and-events/conferences/pm-conference.

The Advisory Council briefly considered potential updates such as revising the "topics for further exploration" identified in the draft report into Advisory Council findings and creating further content for the "Next Steps" section. Chair Hayes also introduced the prospect of incorporating an additional document into the report. That document, which he initiated, provides responses to the questions originally posed by the Advisory Council and the Air District to the October PM Symposium panelists (see Appendix for the list of questions). His aim was to distill the information shared by the panelists into concise answers to each of the questions. Ultimately, the Advisory Council determined that because the purpose of the October PM Symposium report was to serve as a record of the October PM Symposium, it was appropriate to limit that report's contents to what had been shared during that event.

Edits to Draft October PM Symposium Report. Three clarifying edits were made to the October PM Symposium report draft, all within the section on "Advisory Council Deliberation." The Advisory Council agreed to release the draft report for public comment following these edits.

Progress of Q&A document. Council Member Solomon volunteered to assist Chair Hayes in further developing the question-and-answer document. Several Advisory Council members made suggestions regarding the draft Q&A:

- Council Members Solomon and Kleinman supported recommending the treatment of PM as a non-threshold toxic. Council Member Kleinman noted that the dose-response relationship appears to be curvilinear rather than linear.
- Council Member Solomon argued for incorporating information from the forthcoming March PM Symposium (focused on community organizations) into the Q&A.
- Council Member Rudolph stated the need to emphasize new evidence for likely causal relationships between PM and specific health effects and the greater sensitivity of vulnerable populations. She also noted the importance of reducing ambient PM levels as much as possible in the presence of events such as wildfires that cannot be placed into a regulatory framework.

Public Comment

Three opportunities were provided for public comment: prior to presentations from Air District staff, following presentations from Air District staff, and toward the close of the meeting following Advisory Council deliberation on the October PM Symposium Summary draft report. A list of the commenters follows; their comments are categorized by topic and summarized below.

List of Commenters

Dr. Ashley McClure, primary care physician, Oakland
Jed Holtzman, 350 Bay Area
Greg Karas, Communities for a Better Environment
Richard Grey, 350 Bay Area

Comments

Structure of public comment. Dr. McClure suggested that comment on agenda items should take place after the agenda items had been discussed by presenters and the Advisory Council. Mr. Holtzman requested that the Advisory Council determine and publicize the timing of public comment periods in advance of Advisory Council meetings. Council Member Borenstein concurred with Mr. Holtzman's suggestion, and Chair Hayes indicated that the Advisory Council would implement this suggestion by formally determining public comment periods in advance so that people who wish to comment can plan when to be present at Advisory Council meetings.

Urgency. Dr. McClure stated that the October PM Symposium left little ambiguity regarding the health impacts of PM and asked why further symposia were necessary prior to rulemaking. Mr. Holtzman also questioned the pace of progress and the duration of time between meetings. Council Member Borenstein stated that while the Advisory Council was interested in recommending the Air District move toward stricter PM controls, it was not yet clear precisely what the targets should be. He emphasized the importance of measured and deliberative action, as rulemaking is likely to be challenged in court.

Strong statements. Addressing the need to establish a public record to support rulemaking, Mr. Holtzman urged Advisory Council members to "be very fierce in your statements" regarding the implications of the science.

Zero-carbon economy. All four commenters spoke of a need to phase out fossil fuel combustion and transition to a zero-carbon economy. Tying fossil fuel combustion to the climate conditions that have led to increased wildfires, commenters emphasized that reducing risks from wildfires can only be achieved by reducing the greenhouse gas emissions that ultimately contribute to their frequency.

Air District actions. Commenters recommended specific actions for the Air District:

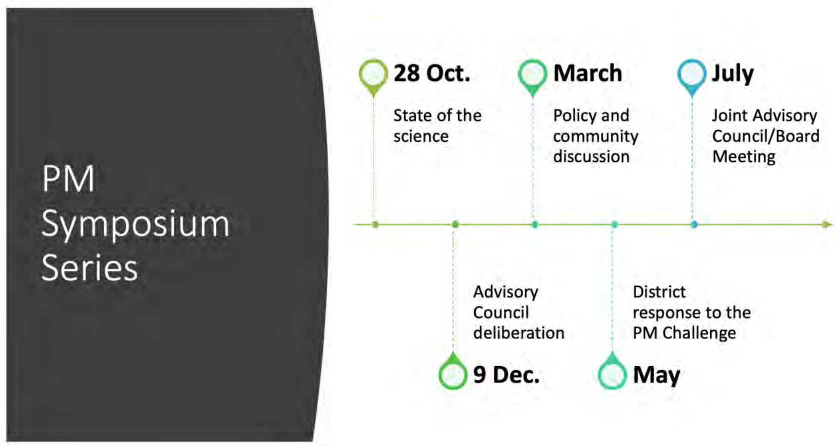
- Set PM threshold levels based on sensitive populations (Holtzman)
- Focus separately on top local and regional sources of PM (Holtzman)
- Update modeling approaches for brake and tire wear and road dust (Holtzman)
- Address agriculture as a source of NH_3 emissions (Holtzman)
- Use fees on PM emitters to support increased instrumentation for speciation (Holtzman)
- Increase attention to black carbon, which has both health and climate impacts (Holtzman)
- Verify low-cost sensors and utilize their data once verified (Holtzman)
- Tighten controls on ultrafine particles, exposure to which is an environmental justice issue as risks are closely associated with proximity to sources (Karas)
- Utilize findings from the California Household Exposure Study, which measured indoor and outdoor $PM_{2.5}$ concentration levels and found both to be higher near refineries (Karas)
- Focus attention on refineries and the oil industry, particularly fluid cracking units (Grey)
- Develop messaging campaigns to help the public recognize the connection between sources of air pollution and health outcomes (McClure)
- Emphasize, possibly at the March PM Symposium, the meaning and values driving the pursuit of tighter air quality controls; "Give us all something to believe in" (McClure)

Partner actions. Commenters also recommended actions that are outside Air District jurisdiction:

- Pursue a tighter state standard for PM (Holtzman)
- Offer free public transit, either on Spare the Air days or at all times (McClure)

Next Steps

The PM Symposium Series continues as depicted in the timeline below. The next symposium will take place on March 24, 2020, in Oakland, focused on presentations from community organizations and leaders. Planning is currently underway.



Following the March symposium, the May event is expected to focus on formulating potential Air District plans to further reduce Bay Area health risks from PM, particularly for disproportionately impacted communities.

The July event brings together the Advisory Council and the Board of Directors to discuss the information and suggestions shared throughout the PM Symposium Series. During this final meeting in the series, the Advisory Council is expected to present its findings to the Board of Directors regarding particulate matter and health in the Bay Area.

Appendix — Questions from the Advisory Council and Air District sent to October PM Symposium Panelists

GENERAL

- What is bullseye in clean air target? How clean is clean enough?
- How will we know when we get to target? What metrics should we use to track progress?
- How do we combine criteria pollutants and toxics? Cancer and non-cancer health endpoints? Short- and long-term effects?
- How can we make sure everyone is treated fairly?
- How can we ensure that everyone breathes clean air?
- What are most important actions that can be taken now? And, in future?

HEALTH EFFECTS PANEL

- Are current PM standards sufficiently health protective?
- Are some species of PM more dangerous than others?
- What is role of ultrafine particles (UFPs)?
- Should form of target expand to account for more than just mass?
- How should we include draft PM ISA's new "likely-causal" health endpoints (nervous system effects, cancer) and new more sensitive populations (children, lower socio-economic status)?
- What are health impacts of high-concentration acute events (e.g., wildfires)? How should we compare them to day-to-day PM impacts?

EXPOSURE AND RISK PANEL

- What are major sources of PM in the Bay Area?
- What PM levels exist in Bay Area? What health risks do they pose?
- How much additional health benefit can be achieved?
- How should we account for spatial scale of effects (i.e., regional versus local-scale impacts, including proximity to major sources)?
- How should we determine which measures would most move public health needle?

AGENDA: 4

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

PM Health Protection Symposium

(Advisory Council Meeting of October 28, 2019)

Chair Stan Hayes

Advisory Council

December 9, 2019

PM Focus:
Context

- Following three years of intense wildfire smoke, focus on reducing diesel PM emissions, and conclusion that PM is overwhelming health risk driver in Bay Area air
- Air District asked Advisory Council to focus on PM
- Provide Advisory Council's take on latest and best science, in science-affirming way
- Assist Air District to identify those further PM measures that would most move public health needle, especially in most impacted communities

PM Symposia:
Overview

- Convened by Advisory Council as series of meetings
- Engage nationally-recognized experts, including leading experts previously engaged at the Federal level
- Support Air District in identifying health-focused “target” guidelines based on latest science, beyond standards already in effect
- Facilitate Advisory Council feedback on Air District planning
- Include local stakeholders
- Provide national leadership

Key Points

- The National Ambient Air Quality Standard (NAAQS) Science Review Process Worked Well Until 2017
- EPA Administrators Pruitt and Wheeler Have **Broken the Process**
- Particulate Matter Science Review By the EPA Clean Air Scientific Advisory Committee (CASAC) is Highly Deficient: **Appropriate to Look Elsewhere**
- Disbanded CASAC PM Review Panel Reconvened Itself
- Key Findings of the Independent Particulate Matter Review Panel

Particulate Matter:
Spotlight on Health Protection

Bay Area Air Quality Management District

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Particulate Matter:
Spotlight on Health Protection

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

Date: Oct. 28, 2019 **Time:** 9:00 am - 4:45pm **Advisory Council Chair:** Mr. Stan Hayes **Facilitator:** Jeff McKay

Agenda Items

8:30 AM	Registration/Coffee and light breakfast	Atrium
9:00 AM	Welcome	Board Room
9:25 AM	PM Health Effects Panel	Board Room
11:05 AM	Break	Atrium
11:15 AM	Joint Discussion: Health Effects Panel	Board Room
12:00 PM	Lunch with Keynote Speaker – Former EPA Administrator Gina McCarthy	Yerba Buena
1:15 PM	PM Exposure & Risk Panel	Board Room
2:55 PM	Break	Atrium
3:10 PM	Joint Discussion: Exposure & Risk Panel	Board Room
4:00 PM	Advisory Council Deliberation	Board Room

Additional information
This is a meeting of the BAAQMD Advisory Council.
Public comment will take place during welcome remarks.
For ADA related assistance, please contact Areana Flores at aflores@baaqmd.gov.

375 Beale Street, Suite 600, San Francisco, California 94105 • 415.749.5000 • baaqmd.gov

Particulate Matter:
Spotlight on Health Protection

- ~160 registrants
- 2 panels
  - PM Health Effects
  - PM Exposure & Risk
- 9 leading experts

Gina McCarthy

- **Former EPA Administrator**
- Finalized the Clean Power Plan and the Clean Water Rule
- Professor of the Practice of Public Health in the Department of Environmental Health at Harvard T.H. Chan School of Public Health
- Director of the Center for Climate, Health, and the Global Environmental
- Member of the Board of Directors of the Energy Foundation and Ceres
- M.Sc. in Environmental Health Engineering, Planning and Policy from Tuft's University

Jason Sacks, M.P.H.

- Senior Epidemiologist in the Center for Public Health & Environmental Assessment within U.S. EPA's Office of Research and Development
- **Assessment lead for the Particulate Matter Integrated Science Assessment (Draft PM ISA)**
- Key leadership roles in synthesizing the health effects evidence of air pollution for various National Ambient Air Quality Standards reviews
- International training on U.S. EPA's Environmental Benefits Mapping and Analysis Program – Community Edition
- M.P.H. from Johns Hopkins University in 2003

Michael Kleinman, Ph.D.

- UC Irvine Professor of Environmental Toxicology
- Co-Director of the Air Pollution Health Effects Laboratory in the Department of Community and Environmental Medicine
- Adjunct Professor in College of Medicine
- **Serves on the Air District Advisory Council**
- Ph.D. in Environmental Health Sciences from New York University
- **CA Scientific Review Panel on Toxic Air Contaminants; CA Air Quality Advisory Committee**

John R. Balmes, M.D.

- Professor of Medicine at UC San Francisco
- Professor of Environmental Health Sciences in the School of Public Health at UC Berkeley
- Director of the Northern California Center for Occupational and Environmental Health
- Authored over 300 papers on occupational and environmental health-related topics
- **Physician Member of the California Air Resources Board**

H. Christopher Frey, Ph.D., F. A&WMA, F. SRA

- Glenn E. Futrell Distinguished University Professor of Environmental Engineering in the Department of Civil, Construction, and Environmental Engineering at North Carolina State University
- Adjunct professor in the Division of the Environment and Sustainability at the Hong Kong University of Science and Technology
- Fellow of the Air & Waste Management Association and of the Society for Risk Analysis
- Ph.D. in Engineering and Public Policy from Carnegie Mellon
- **Former Chair/Member, EPA Clean Air Scientific Advisory Committee (CASAC)**
- **Former Chair/Member, 10 different CASAC NAAQS Review Panels**
- **Chair, Independent PM Review Panel**

Lauren Zeise, Ph.D.

- **Appointed by Gov. Brown as Director of the California Office of Environmental Health Hazard Assessment in December 2016**
- Former Chief of the cancer unit at the California Department of Health Services
- Leading role in OEHHA’s development of CalEnviroScreen
- Co-led the team that developed the hazard trait regulation for California’s Safer Consumer Products program
- Member, fellow, former editor, and former councilor of the Society for Risk Analysis
- 2008 recipient of the Society’s Outstanding Risk Practitioner Award
- Ph.D. from Harvard University

Julian Marshall, Ph.D.

- **Kiely Endowed Professor of Environmental Engineering at University of Washington with a focus on air quality management**
- Founded and runs the Grand Challenges Impact Lab, a UW study abroad program in Bangalore, India
- Associate Editor for Environmental Health Perspectives and Development Engineering
- Published over 100 peer-reviewed journal articles
- Ph.D. in Energy and Resources from UC Berkeley

Scott Jenkins, Ph.D.

- Senior Environmental Health Scientist in EPA's Office of Air Quality Planning and Standards (OAQPS)
- **Currently leading EPA's review of the National Ambient Air Quality Standards (NAAQS) for Particulate Matter (PM)**
- Howard Hughes Postdoctoral Research Fellow in the Department of Cell Biology at Duke University
- Ph.D. in Behavioral Neuroscience from the University of Alabama at Birmingham

Phil Martien, Ph.D.

- **Director of the Assessment, Inventory, & Modeling Division at the Bay Area Air Quality Management District**
- Leading role in the Technical Assessment of AB617's West Oakland Community Action Plan
- Leading role in the Technical Assessment of the Air District's 2017 Clean Air Plan: Spare the Air, Cool the Climate
- Leading role in the Air District's Community Air Risk Evaluation Program
- Ph.D. from UC Berkeley

PM Health Effects Panel

PM Exposure & Risk Panel

Advisory Council Discussion with Experts

BAAQMD's Questions

Example Response

- Are current PM standards sufficiently protective? **Emphatic NO – definitely not for $PM_{2.5}$.**
- How has the PM health evidence been strengthened? **Better "exposure" models, much larger study populations at much lower levels than before.**
- What new health effects are now recognized? **Strengthening of some causality determinations, but largely the focus is still premature mortality, respiratory morbidity, and cardiovascular morbidity.**
- New endpoints like cancer and central nervous system effects? **Opinions differ.**
- New sensitive groups, like children and lower socioeconomic status, SES, populations? **Growing recognition of "at risk" groups.**
- Are all types of PM equal? **Probably not.** Or, are some more dangerous than others? **Probably. But, more work needed. No components are as yet 'exonerated.'**
- How severe are PM health risks? **Premature mortality is severe.**
- What additional health benefits can be achieved by further reducing PM to below current standards? **Difficult to quantify with certainty but on the order of tens of thousands of deaths nationally.**

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Discussion Questions (EXAMPLE, DO NOT CITE)

Are current PM standards sufficiently health protective?

NOT PROTECTIVE, STANDARDS SHOULD BE LOWERED

Are some species of PM more dangerous than others?

QUITE POSSIBLY BUT NOT ENOUGH INFORMATION, NO PM COMPONENTS "EXONERATED"

What is role of ultrafine particles (UFPs)?

NOT YET CLEAR, TOX STUDIES OF CONCERN, NEED UFP FEDERAL REFERENCE METHOD, MORE MONITORING, EPI STUDIES

Should PM "target" expand to account for more than just mass?

IN RESEARCH ABSOLUTELY, IN REGULATION TOO SOON, UNLESS HIGHLY RISK-AVERSE

How should we include draft PM ISA's new "likely-causal" health endpoints (nervous system effects, cancer) and new more sensitive populations (children, lower socio-economic status)?

NEW HEALTH EFFECTS AND GROWING RECOGNITION OF "AT RISK" GROUPS IMPORTANT (SUCH AS CHILDREN AND LOW SES), NEED TO CONSIDER

What are health impacts of high-concentration acute events (e.g., wildfires)? How should we compare them to day-to-day PM impacts?

NOT WELL-KNOWN SCIENTIFICALLY BUT OF CONCERN, DATA ON SUB-DAILY EXPOSURES TOO LIMITED AS YET, POTENTIALLY SERIOUS EFFECTS IN EARLY STUDIES, OTHER STUDIES ONGOING, MORE RESEARCH NEEDED

Advisory Council:
Initial Deliberation

Sense of the Council

- The current standards are not adequately health protective.
- Further reductions in PM will realize significant additional health benefits.
- We need more science, *and* we should act now.

Further Exploration

- Treating PM as an air toxic
- Expanded monitoring of UFP
- Health effects of acute PM exposures, e.g., wildfire smoke
- Identifying PM species that are particularly dangerous
- Assisting District in identifying strategies having "highest bang for buck" for health protection
- Pursuing strategies that have climate and other co-benefits

PM Symposium Series

28 Oct.
State of the science

9 Dec.
Advisory Council deliberation

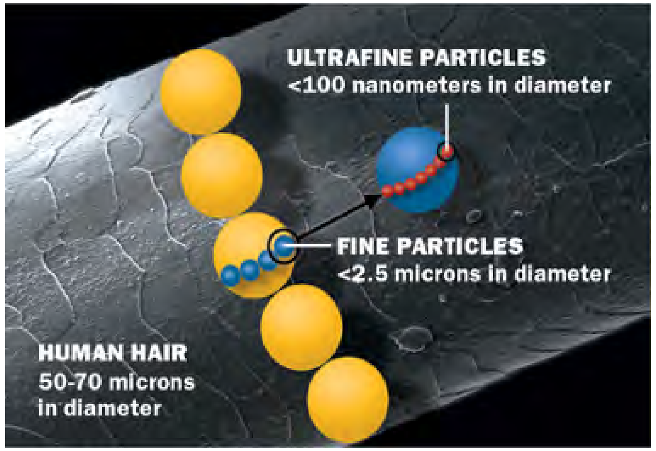
March
Policy and community discussion

May
District response to the PM Challenge

July
Joint Advisory Council/Board Meeting

Ambient Particulate Matter (PM)

- PM is a mixture, including particles of differing origin (combustion, crustal, biological) and varying size.
- Multiple sources



Mortality – Long-term $PM_{2.5}$ Exposure

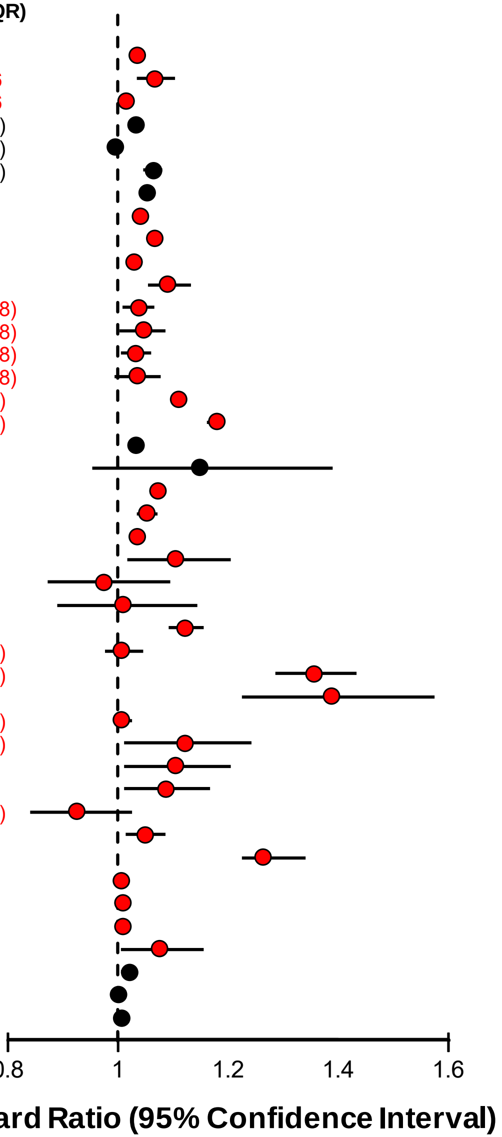
Recent evidence supports and extends the conclusions of the 2009 PM ISA that there is a causal relationship between long-term $PM_{2.5}$ exposure and mortality

Figure 11-18. Associations between long-term $PM_{2.5}$ and total (nonaccidental) mortality in recent North American cohorts.

Note: Associations are presented per 5 μg/m^3 increase in pollutant concentration.

Red = recent studies;
Black = studies evaluated in the 2009 PM ISA

Reference	Cohort	Notes	Years	Mean (IQR)
†Pope et al. 2014	ACS		1982-2004	12.6
†Lepeule et al. 2012	Harvard Six Cities		1974-2009	11.4-23.6
†Thurston et al. 2015	NIH-AARP		2000-2009	10.2-13.6
Zeger et al. 2008	MCAPS	Eastern	2000-2005	14.0 (3.0)
Zeger et al. 2008	MCAPS	Western	2000-2005	13.1 (8.1)
Zeger et al. 2008	MCAPS	Central	2000-2005	10.7 (2.4)
Eftim et al. 2008	ACS-Medicare		2000-2002	13.6
†Di et al. 2017	Medicare		2000-2012	11.5
†Di et al. 2017	Medicare	exp<12	2000-2012	11.5
†Di et al. 2017	Medicare	nearest monitor	2000-2012	11.5
†Kioumourtzoglou et al. 2016	Medicare		2000-2010	12
†Shi et al. 2015	Medicare	mutual adj	2003-2008	8.12 (3.78)
†Shi et al. 2015	Medicare	exp <10, mutual adj	2003-2008	8.12 (3.78)
†Shi et al. 2015	Medicare	no mutual adj	2003-2008	8.12 (3.78)
†Shi et al. 2015	Medicare	exp <10, no mutual adj	2003-2008	8.12 (3.78)
†Wang et al. 2017	Medicare		2000-2013	10.7 (3.8)
†Wang et al. 2017	Medicare	exp<12	2000-2013	10.7 (3.8)
Lipfert et al. 2006	Veterans Cohort		1997-2001	14.34
Goss et al. 2004	U.S. Cystic Fibrosis		1999-2000	13.7
†Crouse et al. 2012	CanCHEC	Satellite data	1991-2001	8.9
†Crouse et al. 2012	CanCHEC	Monitor data	1991-2001	11.2
†Crouse et al. 2015	CanCHEC		1991-2006	8.9
†Chen et al. 2016	EFFECT		1999-2011	10.7
†Weichenthal et al. 2014	Ag Health		1993-2009	8.84
†Weichenthal et al. 2014	Ag Health	more precise exp	1993-2009	8.84
†Pinault et al. 2016	CCHS		1998-2011	6.3
†Lipsett et al. 2011	CA Teachers		2000-2005	15.6 (8.0)
†Ostro et al. 2010	CA Teachers	within 30 km	2002-2007	17.5 (6.1)
†Ostro et al. 2010	CA Teachers	within 8 km	2002-2007	17 (6.1)
†Ostro et al. 2015	CA Teachers		2001-2007	17.9 (9.6)
†Puett et al. 2009	Nurses Health		1992-2002	13.9 (3.6)
†Hart et al. 2015	Nurses Health	nearest monitor	2000-2006	12.7
†Hart et al. 2015	Nurses Health	spatio-temp. model	2000-2006	12
†Puett et al. 2011	Health Prof	full model	1989-2003	17.8 (4.3)
†Hart et al. 2011	TrIPS		1985-2000	14.1 (4)
†Kloog et al. 2013	MA cohort	CVD+Resp	2000-2008	9.9 (1.6)
†Garcia et al. 2015	CA cohort	Kriging	2006	13.06
†Garcia et al. 2015	CA cohort	IDW	2006	12.94
†Garcia et al. 2015	CA cohort	closest monitor	2006	12.68
†Wang et al. 2016	NJ Cohort		2004-2009	11.3
Enstrom 2005	CA Cancer Prev		1973-1982	23.4
Enstrom 2005	CA Cancer Prev		1983-2002	23.4
Enstrom 2005	CA Cancer Prev		1973-2002	23.4



Working Draft: Do Not Cite or Quote

Draft PM ISA Health Effects: Causality Determinations

<u>Table 1-5</u>. Summary of causality determinations for health effect categories for the draft PM ISA.

Draft PM ISA:

- **1,879 pages**
- **2,647 references**

HUMAN HEALTH EFFECTS					
		ISA	Current PM Draft ISA		
		Indicator	$PM_{2.5}$	$PM_{10-2.5}$	UFP
Health Outcome	Respiratory	Short-term exposure			
		Long-term exposure			
	Cardiovascular	Short-term exposure			
		Long-term exposure		*	
	Metabolic	Short-term exposure	*	*	*
		Long-term exposure	*	*	*
	Nervous System	Short-term exposure	*		*
		Long-term exposure	*	*	*
	Reproductive: Male/Female Reproduction and Fertility	Long-term exposure			
	Reproductive: Pregnancy and Birth Outcomes	Long-term exposure			
	Cancer	Long-term exposure	*	*	
	Mortality	Short-term exposure			
		Long-term exposure		*	

Causal **Likely causal** **Suggestive** **Inadequate**

* = new determination or change in causality determination from 2009 PM ISA

Respiratory (LIKELY CAUSAL)

Cardiovascular (CAUSAL)

Nervous System (LIKELY CAUSAL)

Cancer (LIKELY CAUSAL)

Mortality (CAUSAL)

Populations Potentially at Increased Risk of a PM-related Health Effect

- The NAAQS are intended to protect both the population as a whole and those potentially at increased risk for health effects in response to exposure to criteria air pollutants
  - *Are there specific populations and lifestages at increased risk of a PM-related health effect, compared to a reference population?*
- The ISA identified and evaluated evidence for factors that may increase the risk of $PM_{2.5}$-related health effects in a population or lifestage, classifying the evidence into four categories:
  - Adequate evidence; suggestive evidence; inadequate evidence; evidence of no effect
- Conclusions:
  - **Adequate: children and nonwhite populations**
  - Suggestive: pre-existing cardiovascular and respiratory disease, overweight/obese, genetic variants glutathione transferase pathways, low SES
  - Inadequate: pre-existing diabetes, older adults, residential location, sex, diet, and physical activity

Summary of Risk Estimates

Estimates of $PM_{2.5}$-associated deaths in the full set of 47 study areas

Endpoint	Study	Air quality simulation approach*	Current Standad Absolute Risk (12/35 µg/m^3)	CS (12/35) % of baseline**	Alternative Standard Absolute Risk: Alternative Annual (10 µg/m^3)	Alternative Standard Absolute Risk: Alternative 24-hr (30 µg/m^3)
Long-term exposure related mortality						
Ischemic Heart Disease	Jerrett 2016	Pri-PM	16,500 (12,600-20,300)	14.1	14,400 (11,000-17,700)	16,400 (12,500-20,000)
		Sec-PM	16,800 (12,800-20,500)	14.3	14,200 (10,900-17,500)	16,500 (12,600-20,200)
	Pope 2015	Pri-PM	15,600 (11,600-19,400)	13.3	13,600 (10,100-17,000)	15,400 (11,500-19,200)
		Sec-PM	15,800 (11,800-19,600)	13.4	13,400 (9,970-16,700)	15,600 (11,600-19,400)
All-cause	Di 2017	Pri-PM	46,200 (45,000-47,500)	8.4	40,300 (39,200-41,400)	45,700 (44,500-47,000)
		Sec-PM	46,900 (45,600-48,200)	8.5	39,700 (38,600-40,800)	46,200 (44,900-47,500)
	Pope 2015	Pri-PM	51,300 (41,000-61,400)	7.1	44,700 (35,700-53,500)	50,700 (40,500-60,700)
		Sec-PM	52,100 (41,600-62,300)	7.2	44,000 (35,100-52,700)	51,300 (41,000-61,400)
	Thurston 2015	Pri-PM	13,500 (2,360-24,200)	3.2	11,700 (2,050-21,100)	13,300 (2,330-24,000)
		Sec-PM	13,700 (2,400-24,600)	3.2	11,500 (2,010-20,700)	13,500 (2,360-24,200)
Lung cancer	Turner 2016	Pri-PM	3,890 (1,240-6,360)	8.9	3,390 (1,080-5,560)	3,850 (1,230-6,300)
		Sec-PM	3,950 (1,260-6,460)	9.1	3,330 (1,060-5,470)	3,890 (1,240-6,370)
Short-term exposure related mortality						
All cause	Baxter 2017	Pri-PM	2,490 (983-4,000)	0.4	2,160 (850-3,460)	2,460 (970-3,950)
		Sec-PM	2,530 (998-4,060)	0.4	2,120 (837-3,400)	2,490 (982-3,990)
	Ito 2013	Pri-PM	1,180 (-16-2,370)	0.2	1,020 (-14-2,050)	1,160 (-16-2,340)
		Sec-PM	1,200 (-16-2,400)	0.2	1,000 (-14-2,020)	1,180 (-16-2,370)
	Zanobetti 2014	Pri-PM	3,810 (2,530-5,080)	0.7	3,300 (2,190-4,400)	3,760 (2,500-5,020)
		Sec-PM	3,870 (2,570-5,160)	0.7	3,250 (2,160-4,330)	3,810 (2,530-5,070)

* Pri-PM (primary PM-based modeling approach), Sec-PM (secondary PM-based modeling approach)

** CS denotes the current standard.

Current annual standard of

12 ug/m3 =

~ 47 thousand deaths per year

Lower annual standard from

12 to 10 ug/m3 =

~ 6-7 thousand fewer deaths per year (13-15%)

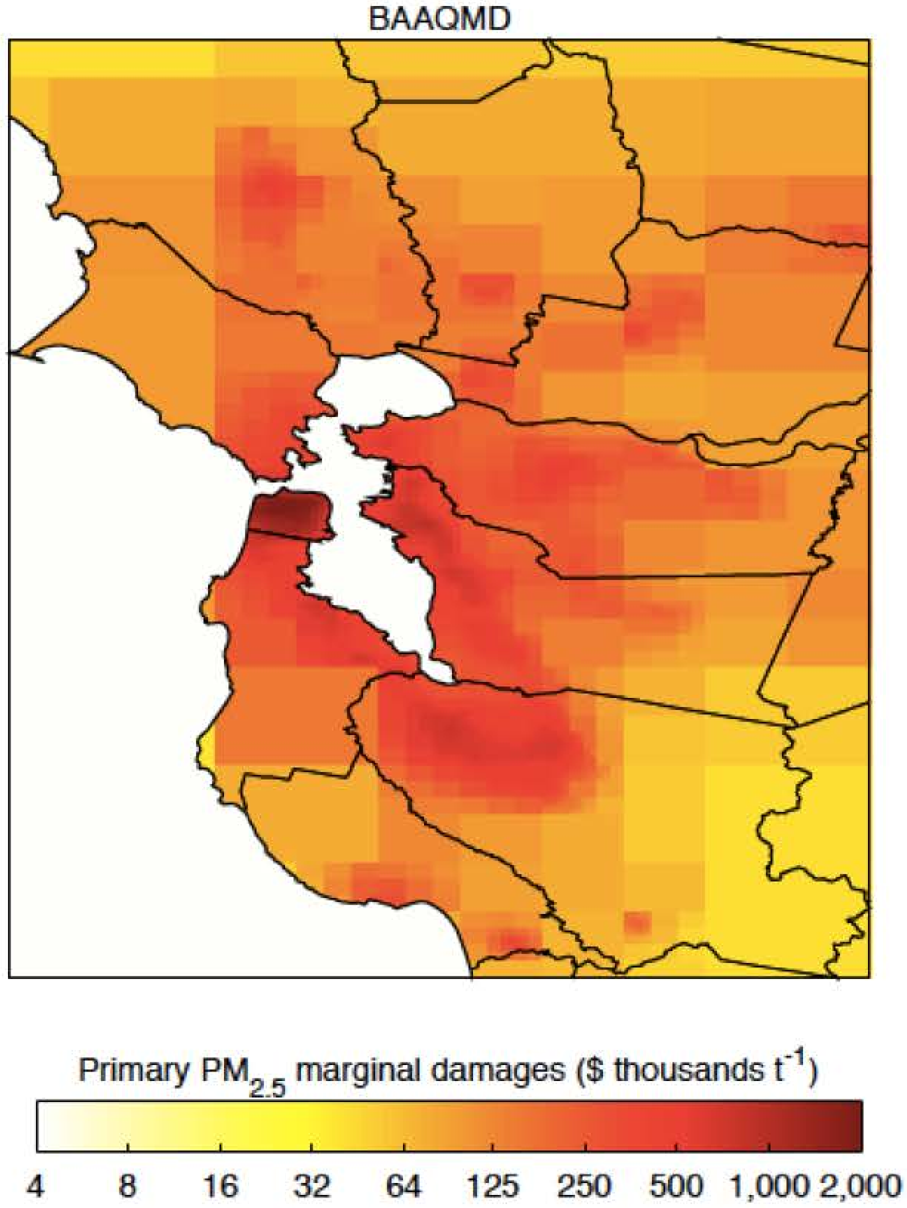
Preliminary Conclusions on the Current Primary $PM_{2.5}$ Standards

- The available scientific information can reasonably be viewed as calling into question the adequacy of the public health protection afforded by the current annual and 24-hour primary $PM_{2.5}$ standards

Draft EPA PM Policy Assessment (PA)

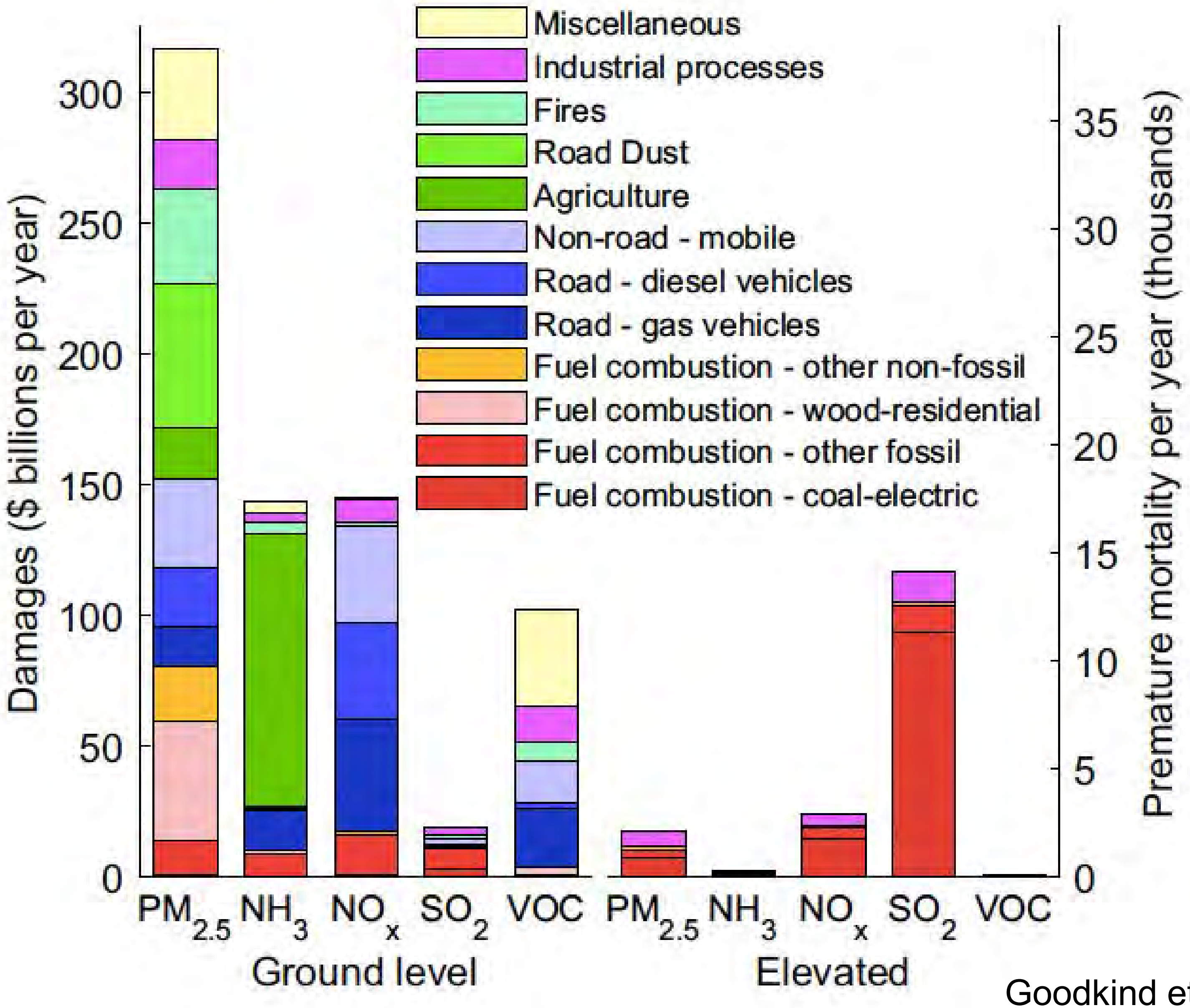
- Basis for this preliminary conclusion:
  - Long-standing body of health evidence, strengthened in this review, supporting relationships between $PM_{2.5}$ exposures and various outcomes, including mortality and serious morbidity effects
  - Recent U.S. and Canadian epidemiologic studies reporting positive and statistically significant health effect associations for $PM_{2.5}$ air quality likely to be allowed by the current standards
  - Analyses of pseudo-design values indicating substantial portions of study area health events/populations in locations with air quality likely to have met the current $PM_{2.5}$ standards
  - Risk assessment estimates that the current primary standards could allow thousands of $PM_{2.5}$-associated deaths per year – most at annual average $PM_{2.5}$ concentrations from 10 to 12 $\mu g/m^3$ (well within the range of overall mean concentrations in key epidemiologic studies)

Primary $PM_{2.5}$ Marginal Damages



Goodkind et al., *PNAS*, 2019

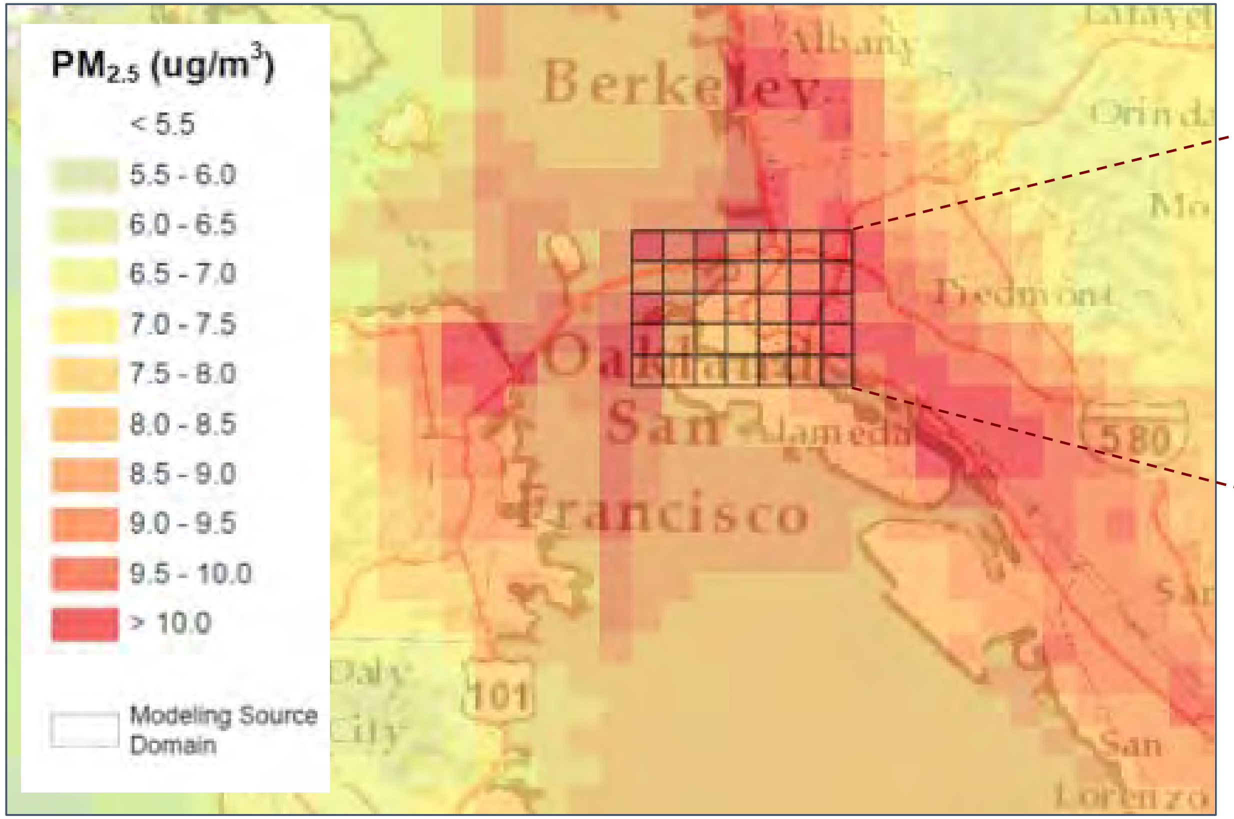
Damages and Premature Mortality



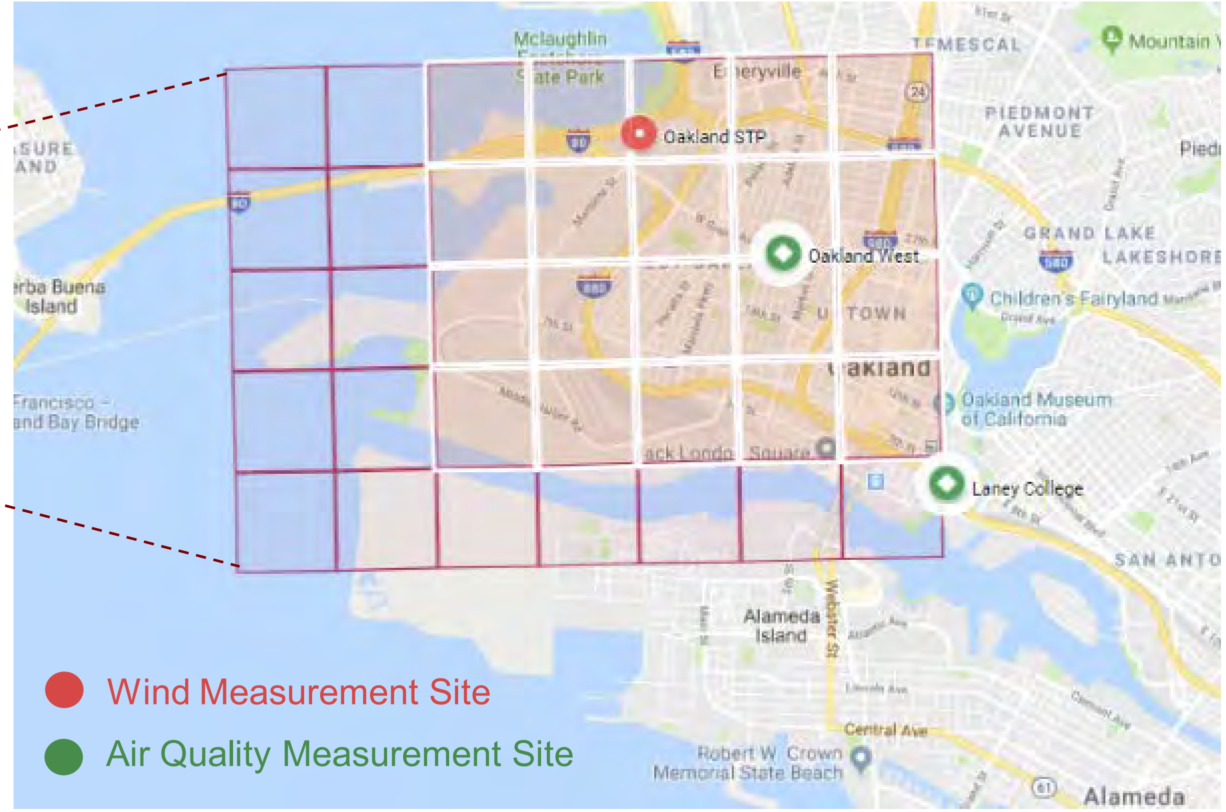
Goodkind et al., *PNAS*, 2019

C300

Regional-Scale and Community-Scale Modeling (2017)



Regional-scale modeling: covers the Bay Area



Local-scale modeling: covers West Oakland, including impacts in receptor area (white) from sources in source area (red)

C301

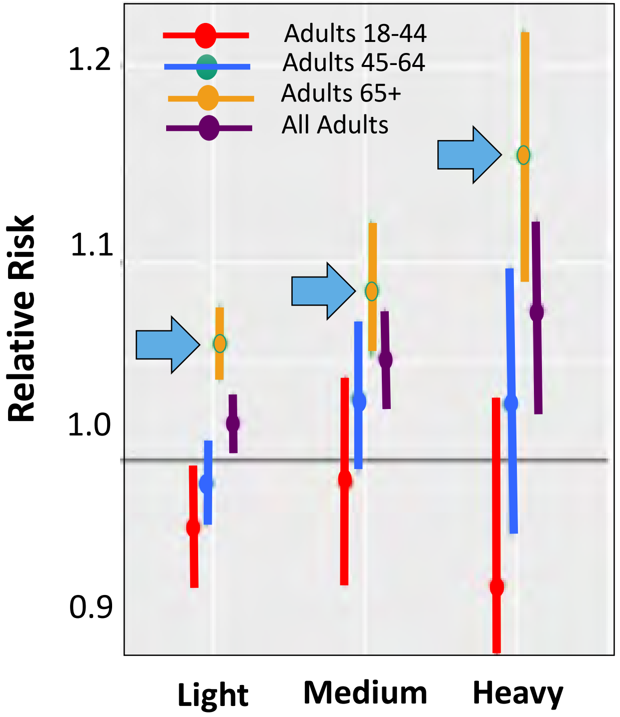
Clear evidence of an association between wildfire smoke and respiratory health

- Asthma exacerbations significantly associated with higher wildfire smoke ***in nearly every study***
- Exacerbations of chronic obstructive pulmonary disease (COPD) significantly associated with higher wildfire smoke in most studies
- Growing evidence of a link between wildfire smoke and respiratory infections (pneumonia, bronchitis)

Wildfire-$PM_{2.5}$ Increases Heart Attack & Stroke

- ***Wildfire-$PM_{2.5}$ associated with heart attacks and strokes for all adults, particularly for those over 65 years old***
- ***Increase in risk the day after exposure:***
  - All cardiovascular, 12%
  - Heart attack, 42%
  - Heart failure, 16%
  - Stroke, 22%
  - All respiratory causes, 18%
  - Abnormal heart rhythm, 24% (on the same day as exposure)

All Cardiovascular Causes



31

Wettstein Z, Hoshiko S, Cascio WE, Rappold AG et al. JAHA April 11, 2018

Slide credit: Wayne Cascio

AGENDA: 5A

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

Update on Particulate Matter (PM) Air District Work:

Regional-and Local-Scale $PM_{2.5}$ Source Apportionment

Phil Martien, PhD
Director of Assessment, Inventory, and Modeling

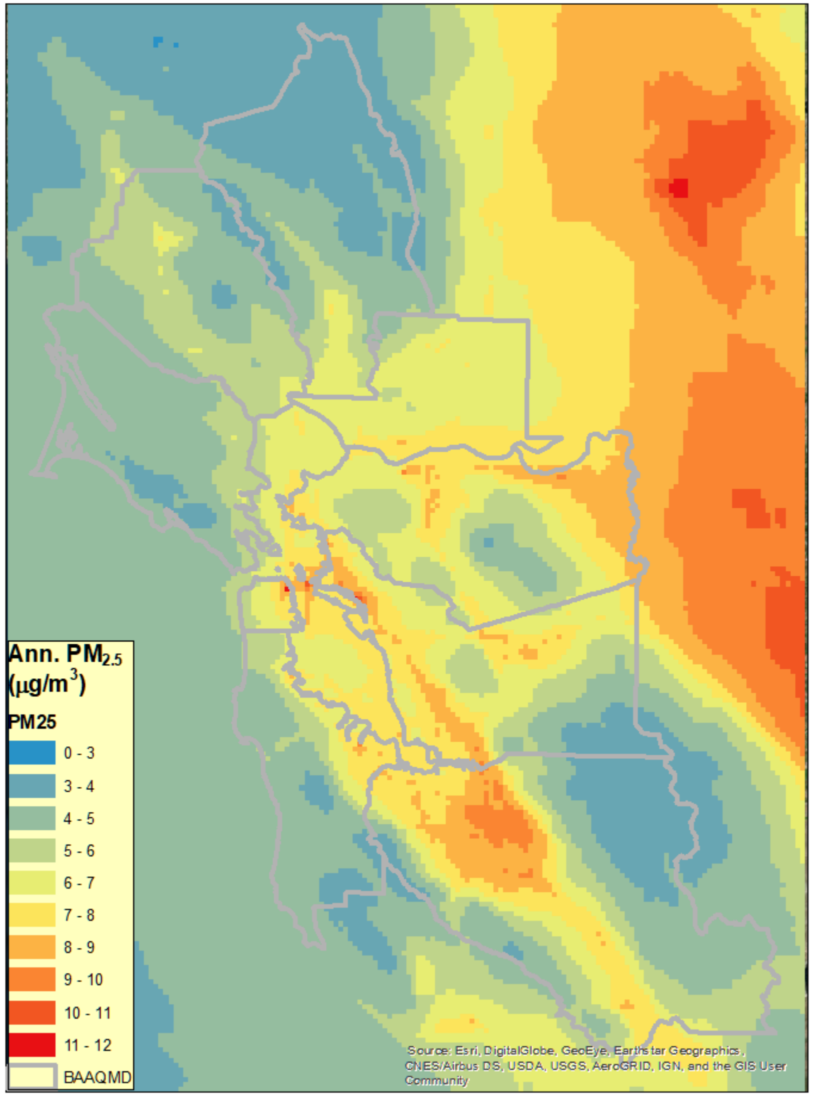
Advisory Council Meeting
December 9, 2019

Overview

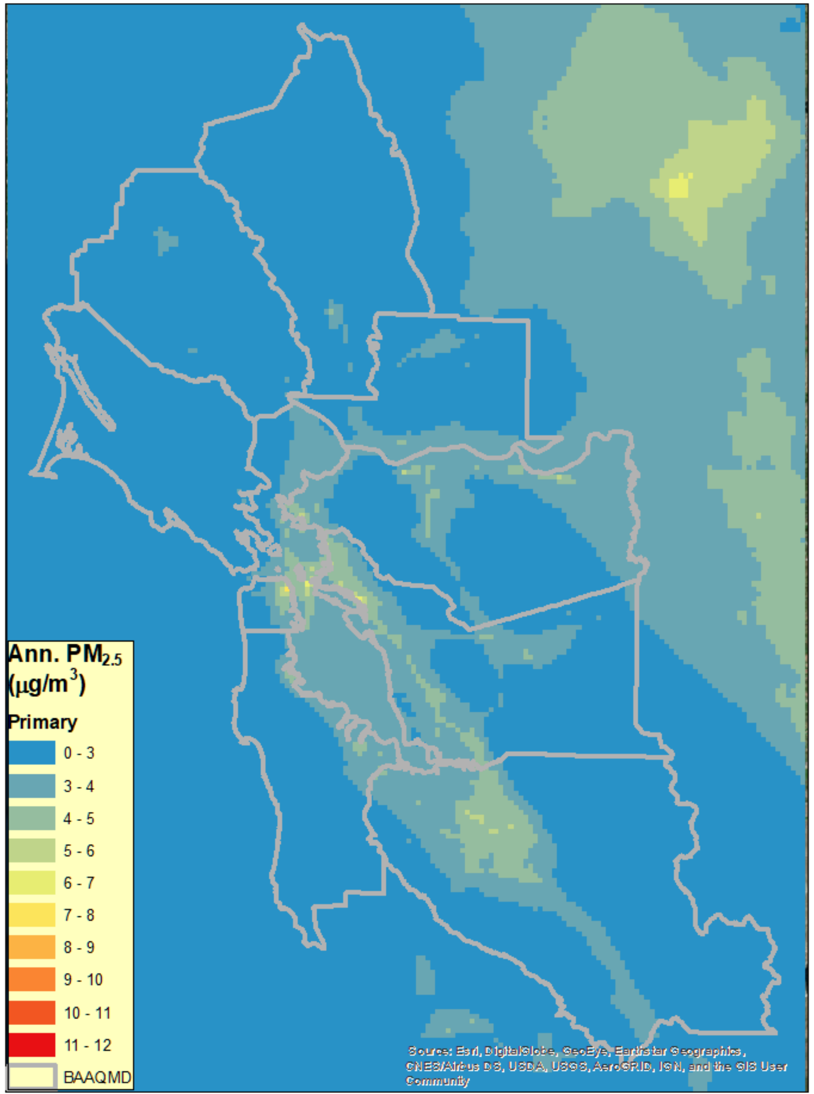
- **Regional-scale $PM_{2.5}$ source apportionment:**
  - Informs actions to maintain attainment of PM standards
  - Reveals information gaps, as top sources are controlled
- **Local-scale $PM_{2.5}$ source apportionment:**
  - Indicates near-source exposures add to total pollution burden
  - Reveals additional information gaps
  - Suggests a regulatory gap: actions to reduce near-source exposures?

Regional Modeling: Primary and Secondary Contributions

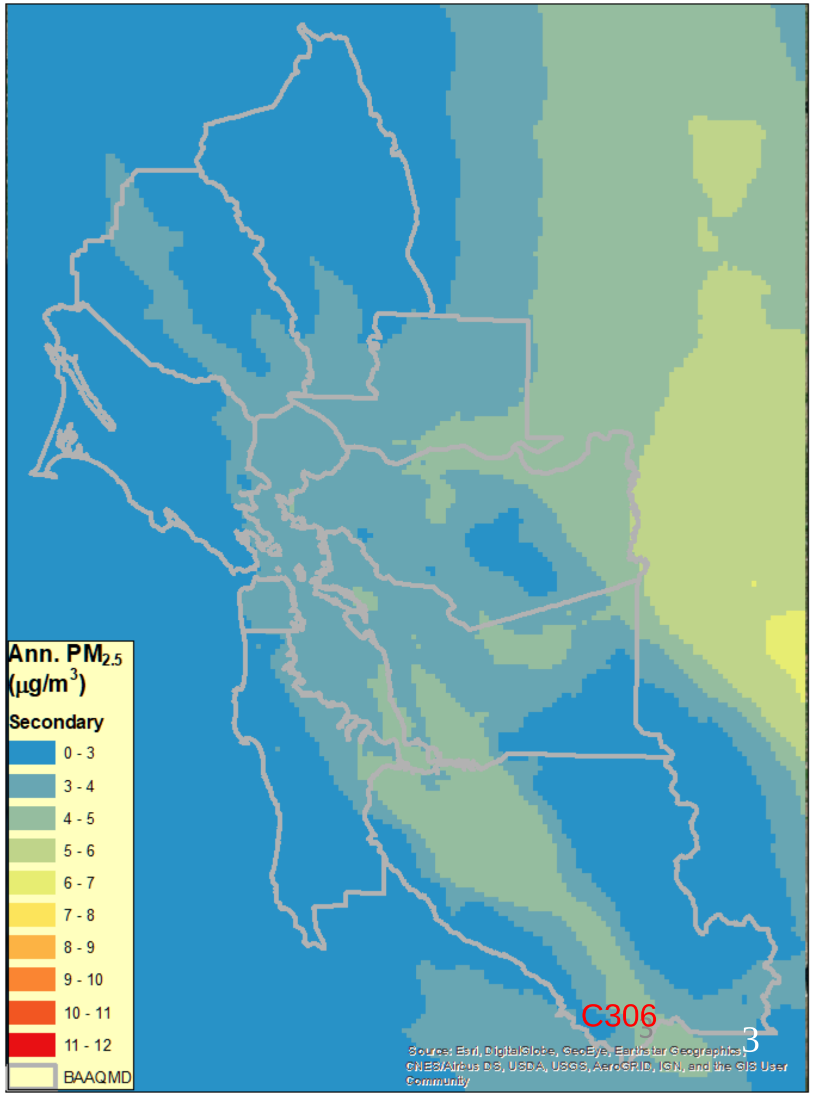
Total $PM_{2.5}$



Primary $PM_{2.5}$ (about 53%)



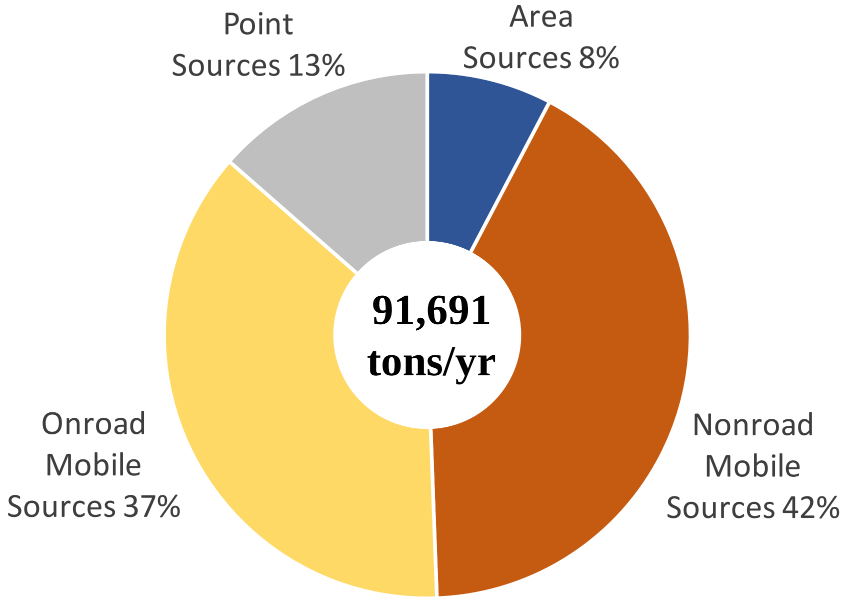
Secondary $PM_{2.5}$ (about 47%)



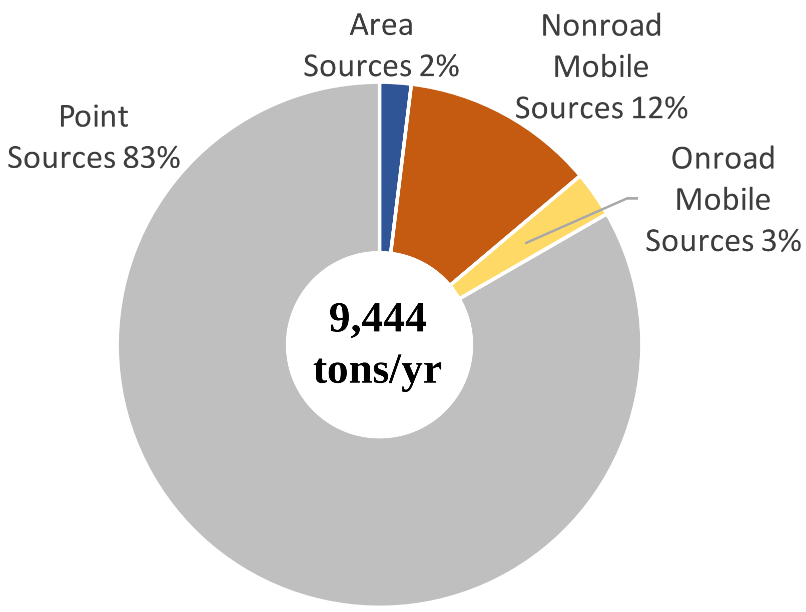
C306

2016 Bay Area Emissions Summary for Key Secondary $PM_{2.5}$ Precursors

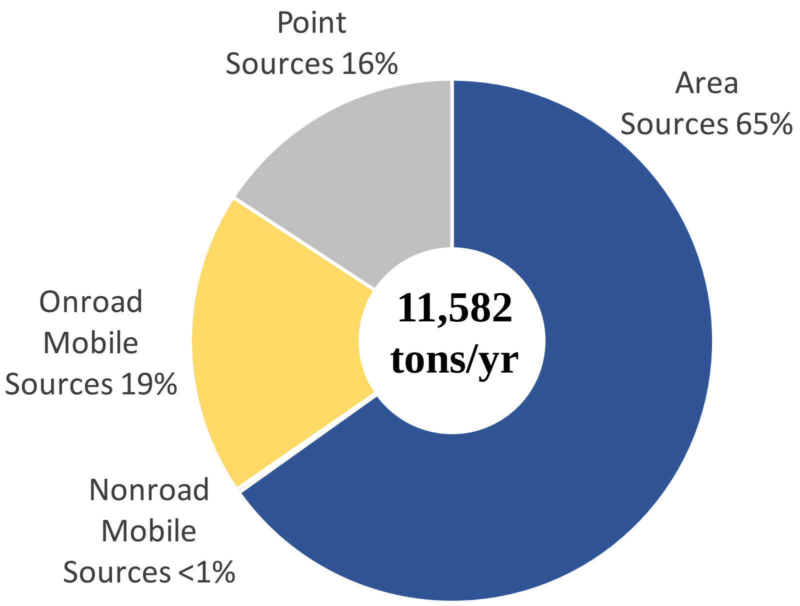
NO_x



SO_2



NH_3



Key NO_x Sources: Diesel trucks and diesel-powered off-road equipment

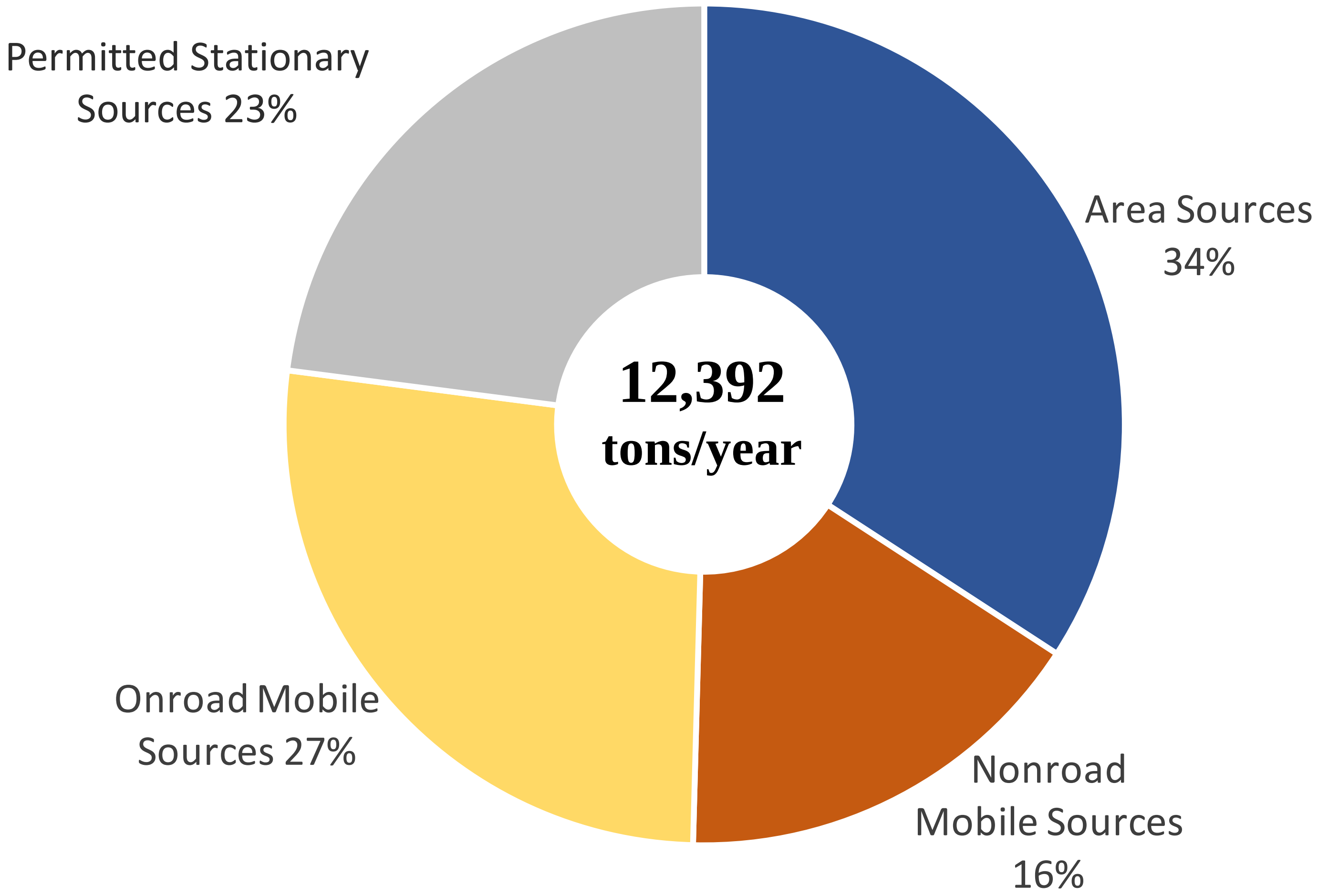
Key SO_2 Sources: Petroleum refineries, manufacturing plants (cement, chemicals)

Key NH_3 Sources: Agricultural activity (livestock husbandry, fertilizer application)

C307

$PM_{2.5}$ Bay Area Emissions Summary for Primary $PM_{2.5}$

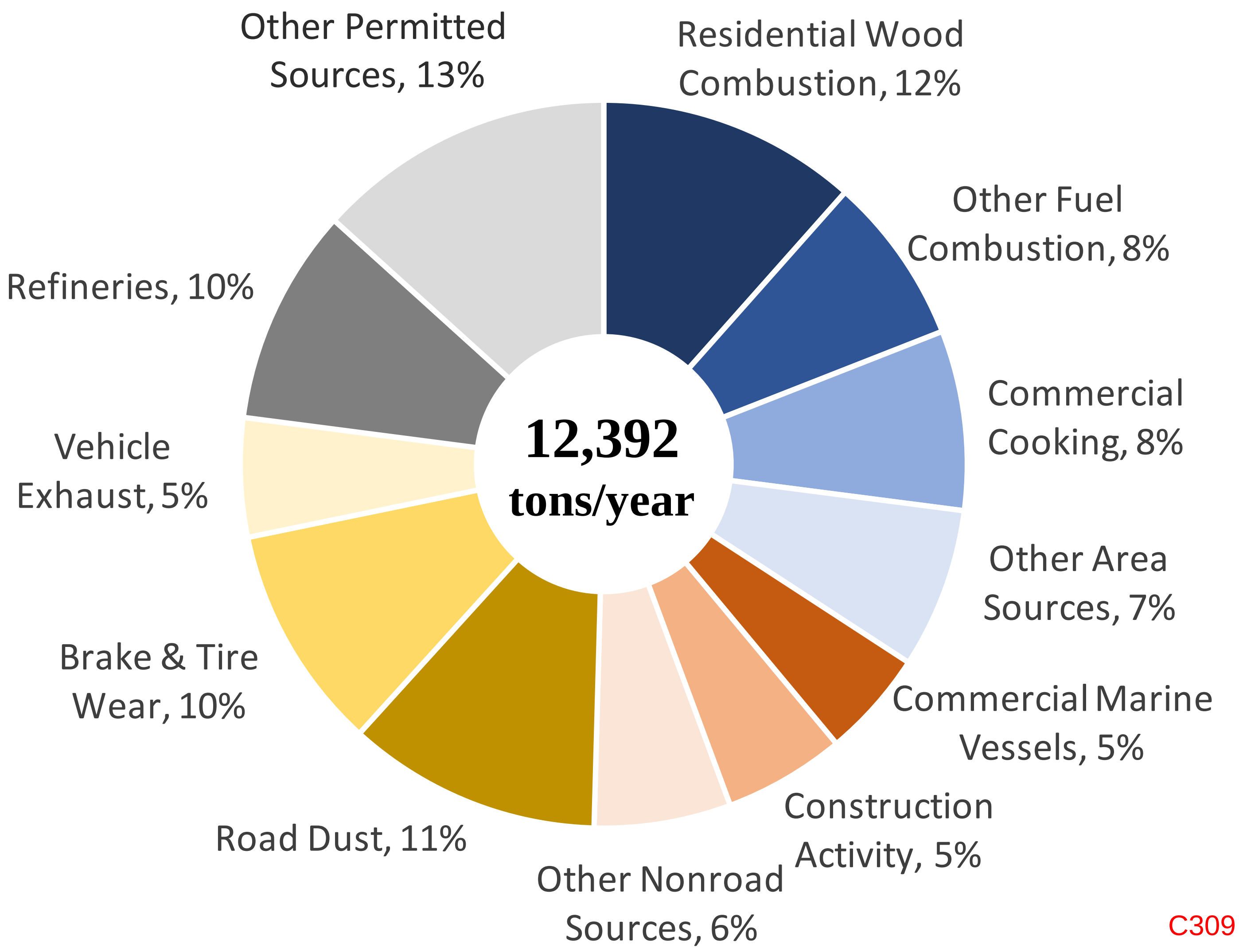
2016 annual average $PM_{2.5}$ emissions



C308

$PM_{2.5}$ Bay Area Emissions Summary for Primary $PM_{2.5}$

2016 annual average $PM_{2.5}$ emissions

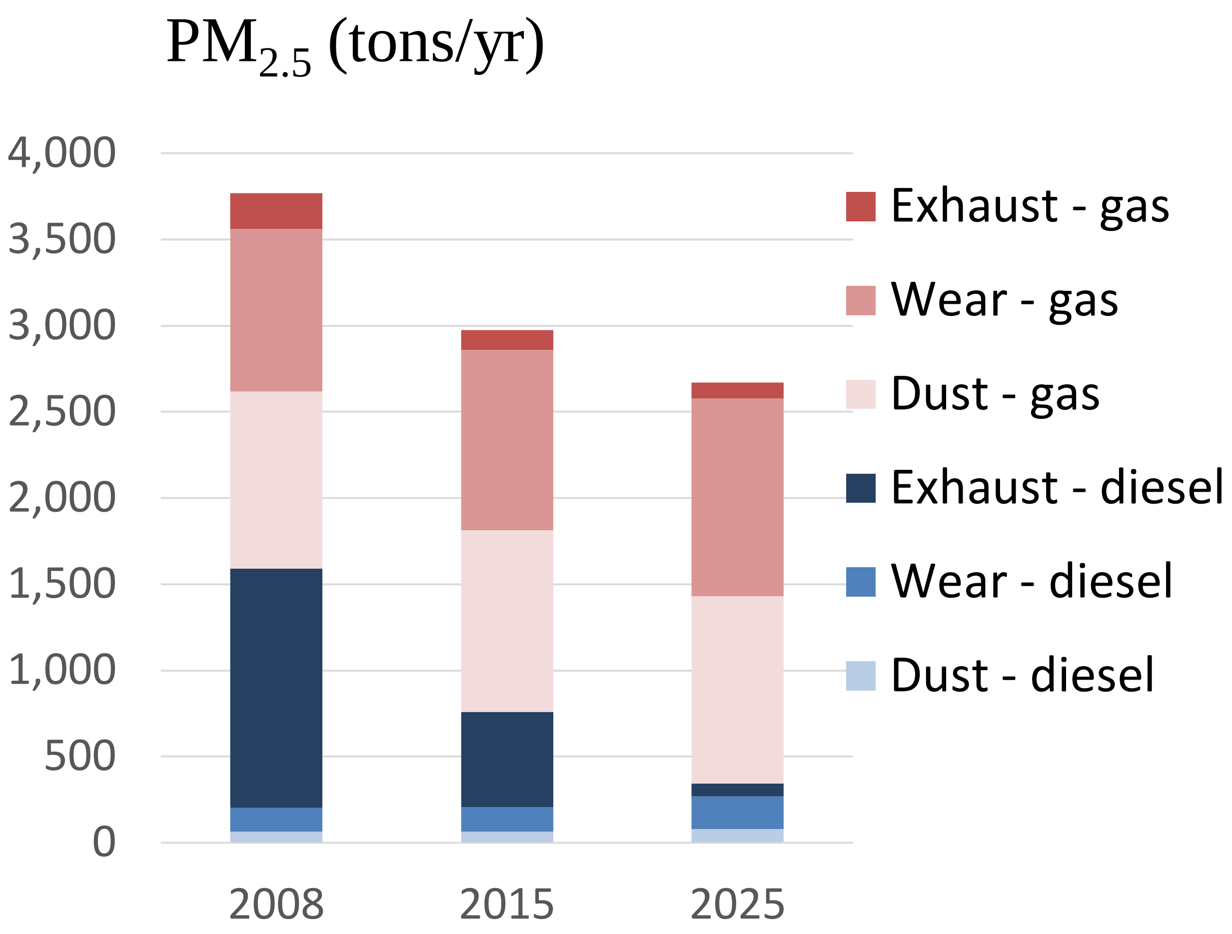


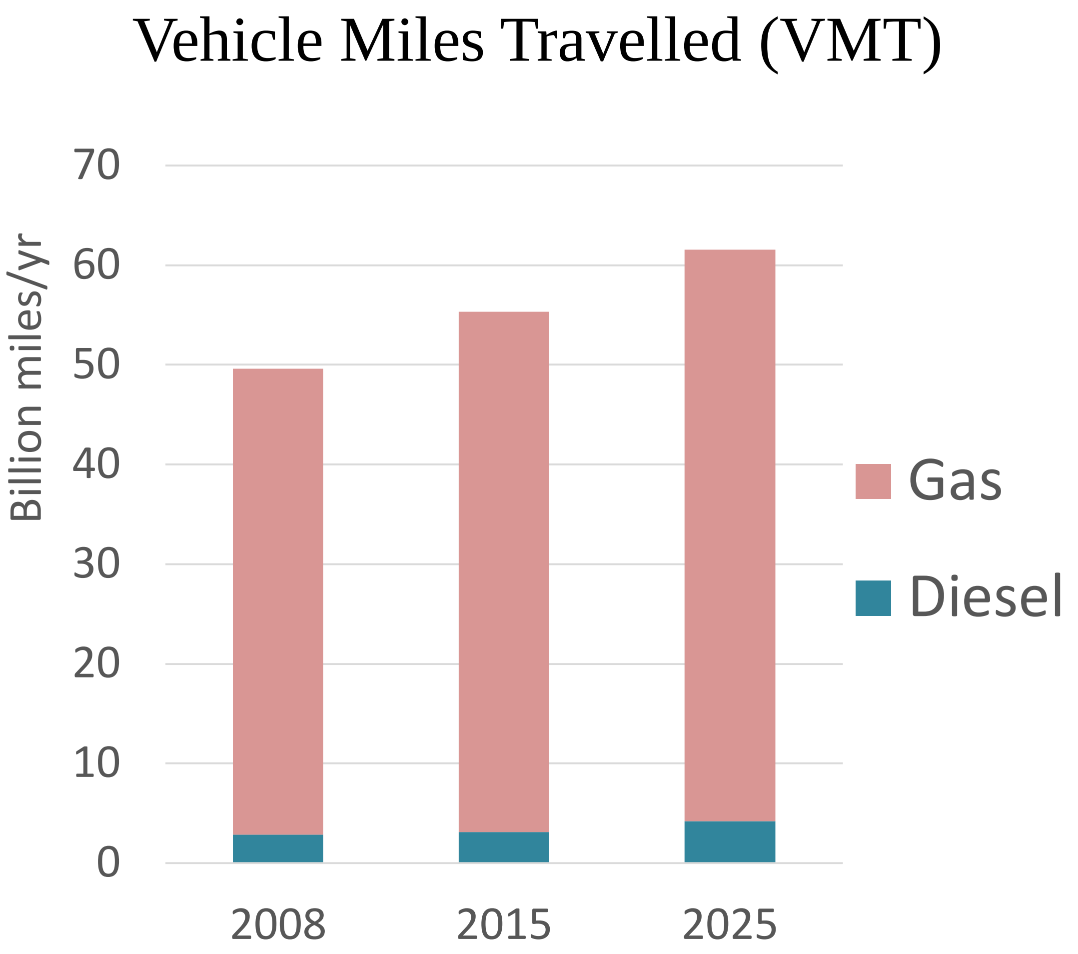
C309

Emissions Inventory Information Gaps

- **On-road wear emissions and road dust**
- **Some area source categories**
  - –Residential wood combustion
  - –Commercial cooking

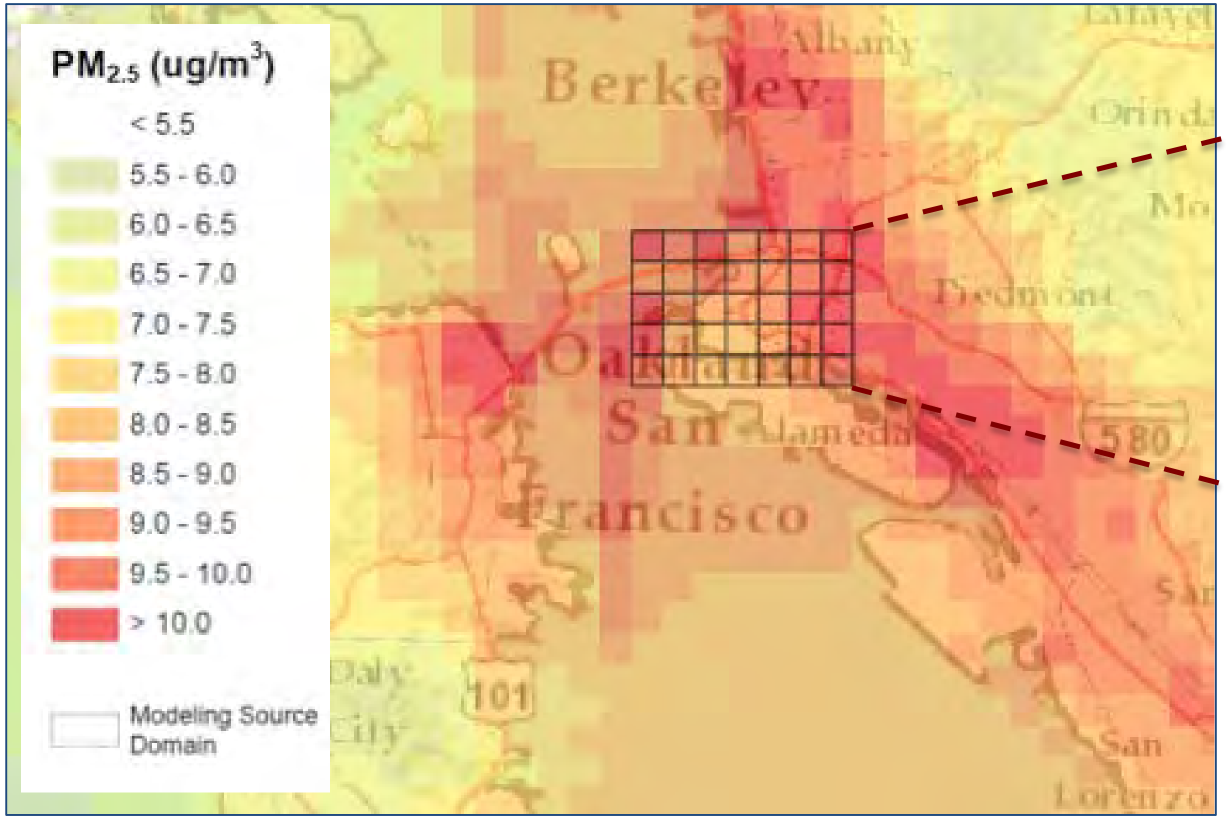
$PM_{2.5}$ Bay Area Emissions Apportionment: On-road Vehicles



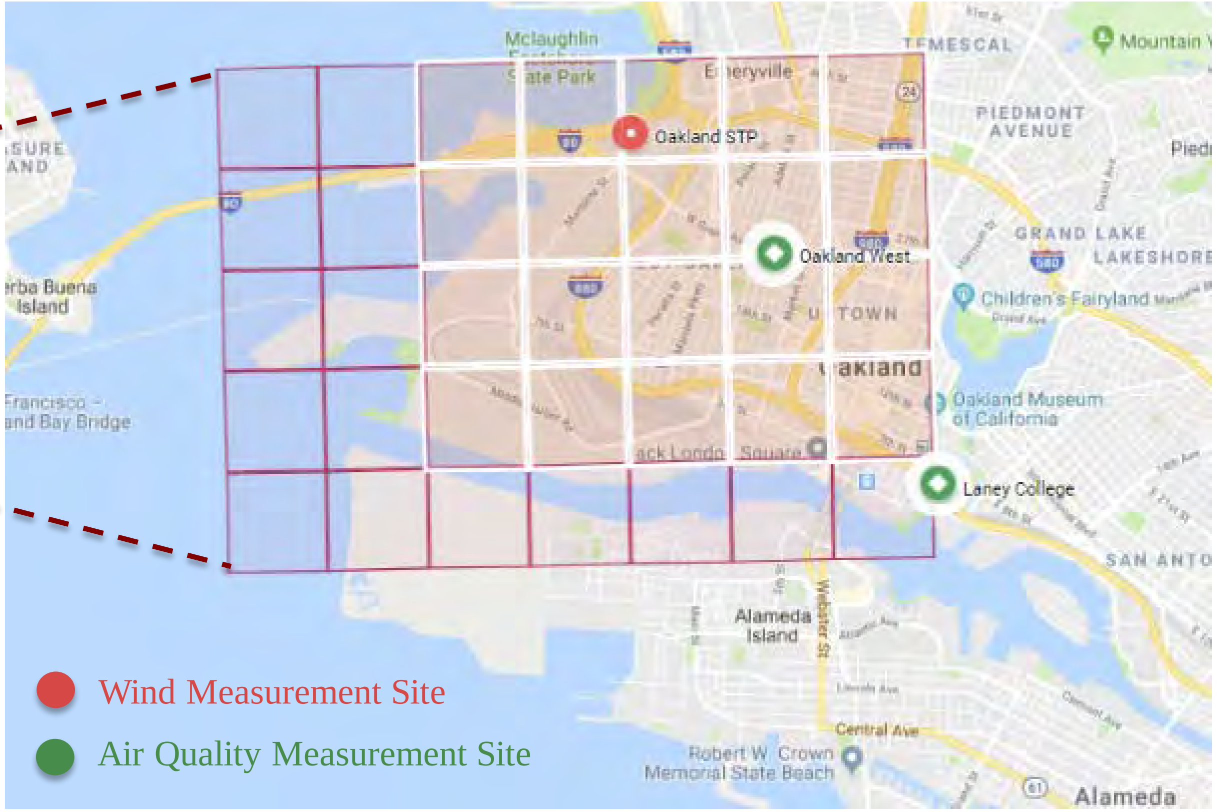


Data sources: EMFAC2017, California Air Resources Board 2016 State Implementation Plan Inventory C311

Regional-Scale and Community-Scale Modeling (2017)



Regional-scale modeling: covers the Bay Area

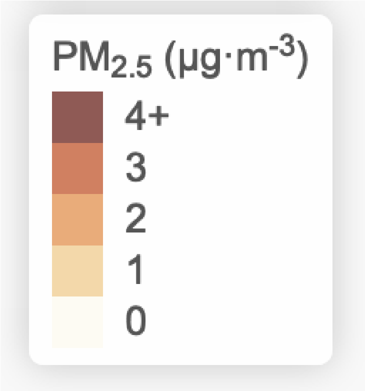


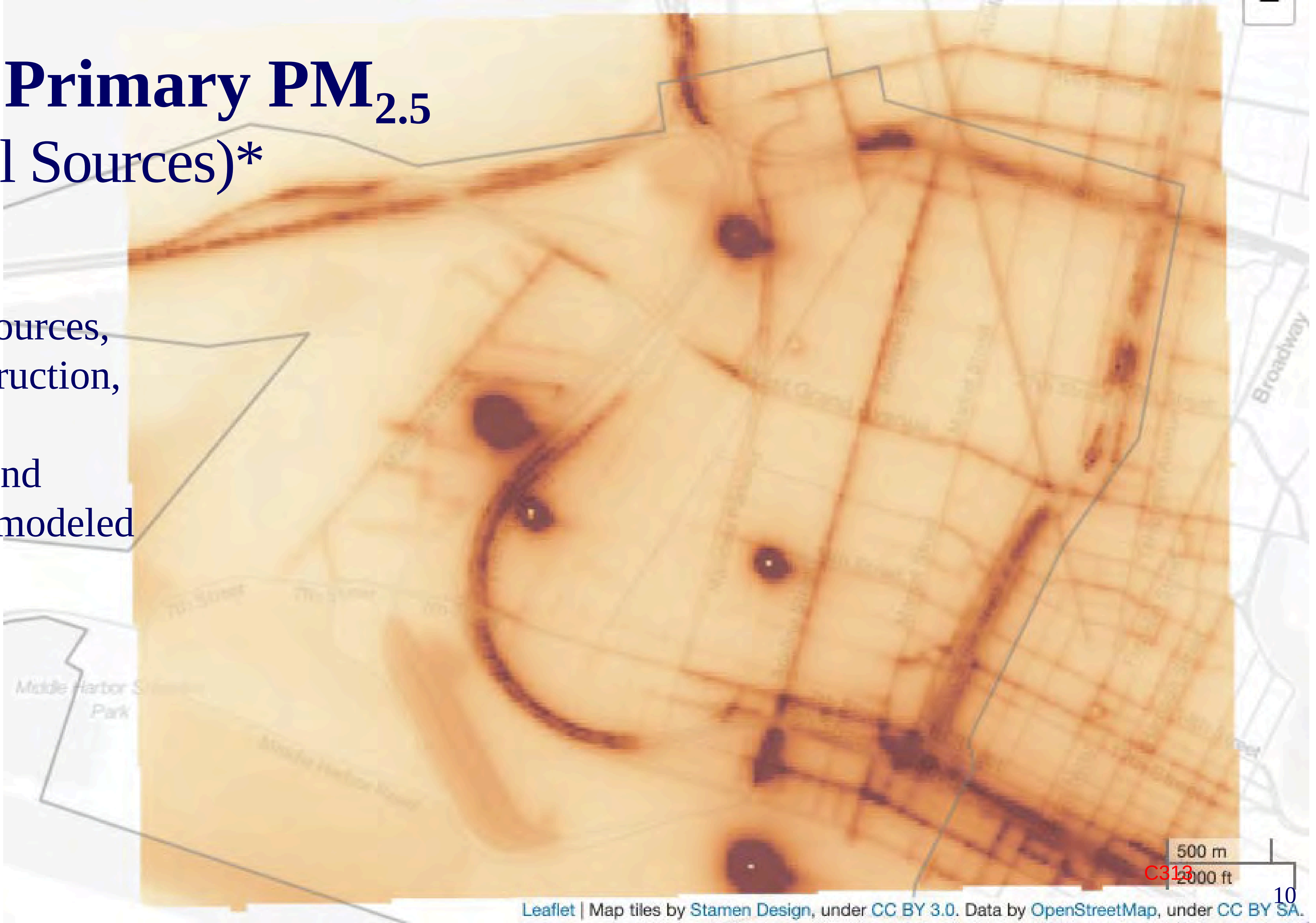
Local-scale modeling: covers West Oakland, including impacts in receptor area (white) from sources in source area (red)

C312

Modeled Primary $PM_{2.5}$
(from Local Sources)*

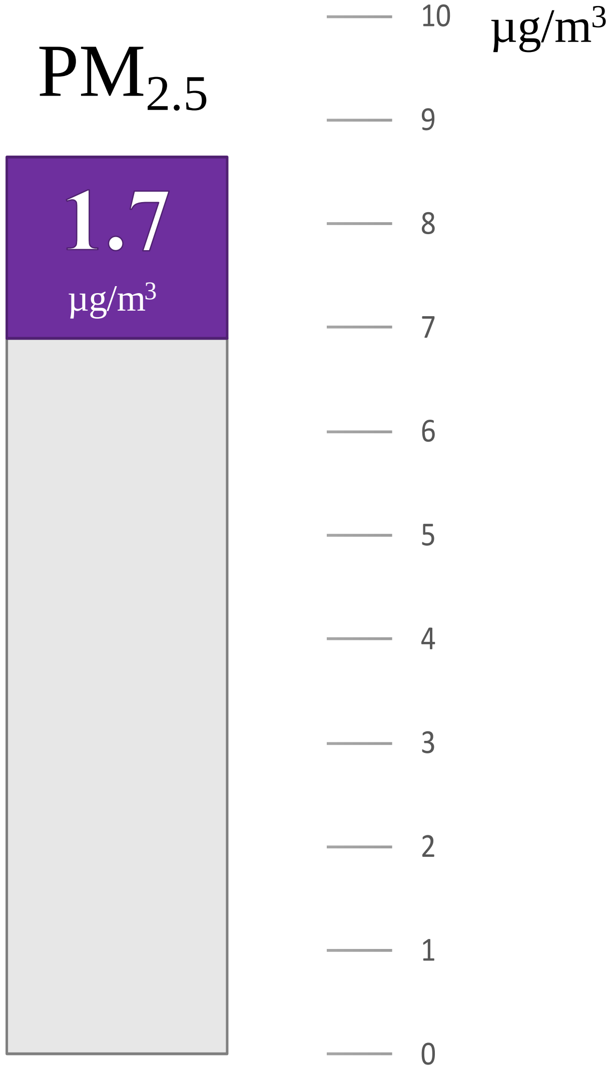
* 30% of $PM_{2.5}$ sources, including construction, residential woodburning, and restaurants not modeled





C313

Local vs. Regional: West Oakland Example



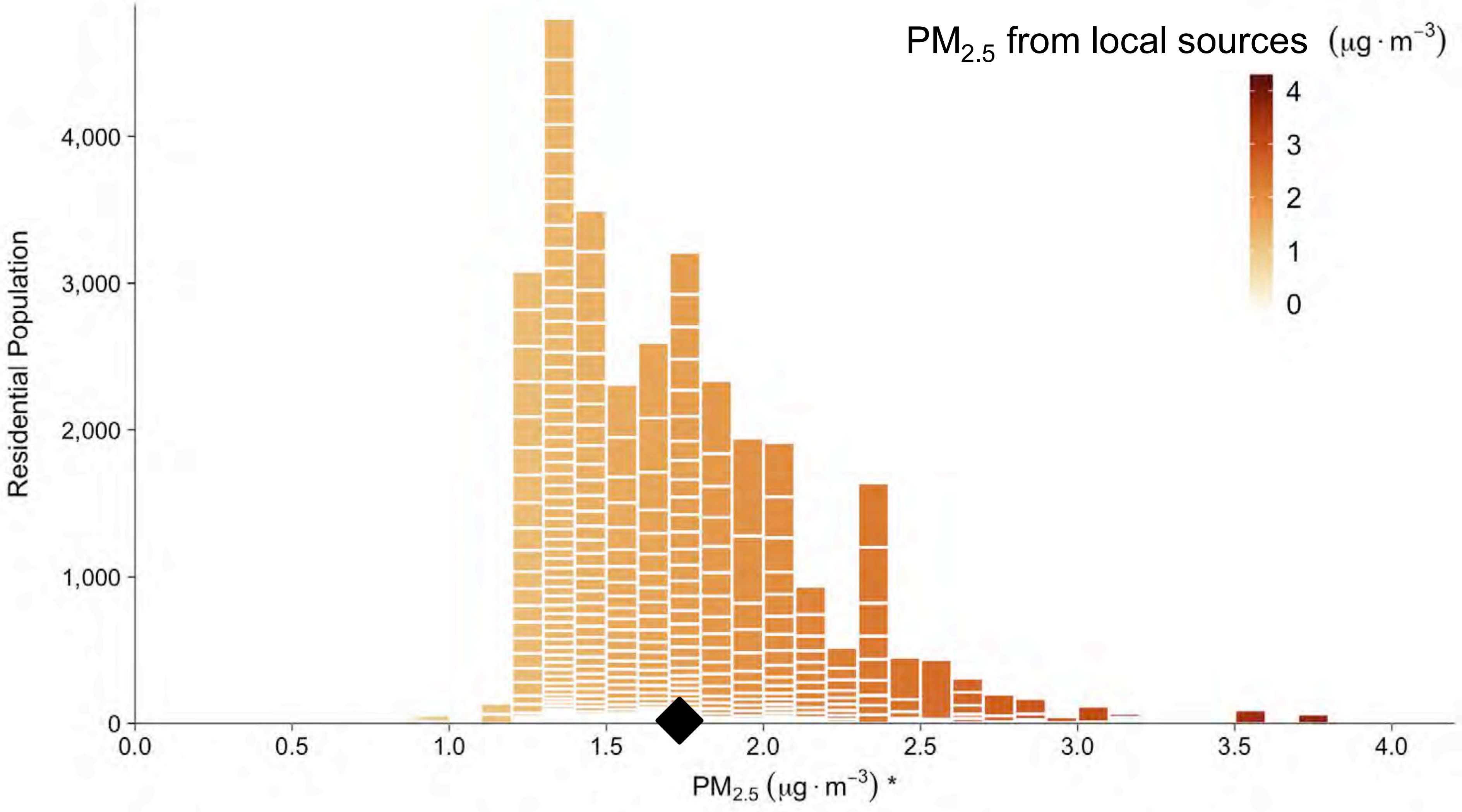
Community-scale model – mapped impacts*

Regional-scale model (minus West Oakland)

*30% of $PM_{2.5}$ sources, including construction, residential woodburning, and restaurants not modeled

C314

Unequal Impacts: $PM_{2.5}$ in West Oakland



* Contributed by modeled "present-day" emissions from existing local sources. Impacts from sources outside West Oakland not included.

DRAFT 2019-08-16

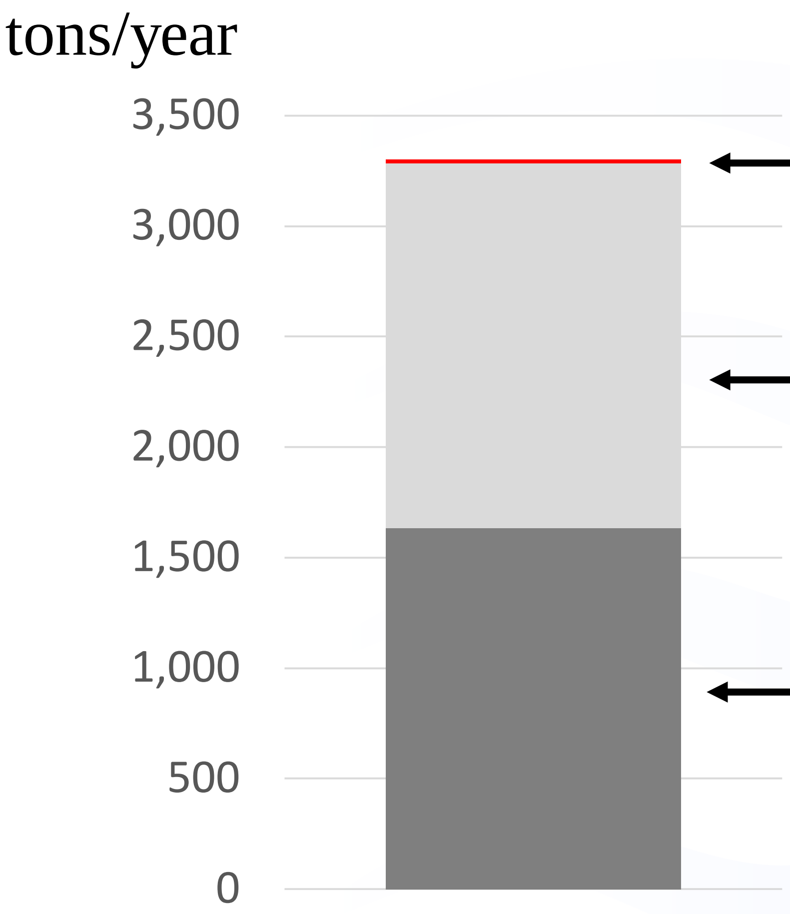
C315

Additional Emissions Inventory Information Gaps Identified

- Local-scale exposures: a different lens for evaluating priorities
- Same concerns about on-road wear and road dust emissions estimates
- We require more information about permitted sources that are not top priorities from a regional perspective

C316

$PM_{2.5}$ Emissions (tons/yr) from Permitted Facilities



West Oakland facilities ≈ **0.5%** (15 tons/yr, within community boundary)

Top 5 facilities (Air District-wide) ≈ **50%**

(All others)

C317

Summary

- Continuing regulatory programs to reduce $PM_{2.5}$ with the current regional focus will improve health throughout the Bay Area
- As top sources are controlled, new sources become priorities and we identify new information gaps
- Local-scale assessments bring to focus the importance of some permitted sources that are a low priority from a regional perspective
- A regulatory gap: a framework that promotes $PM_{2.5}$ reductions from near-source exposures will improve health in Assembly Bill 617 communities

C318

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

Update on Particulate Matter (PM) Air District Work:

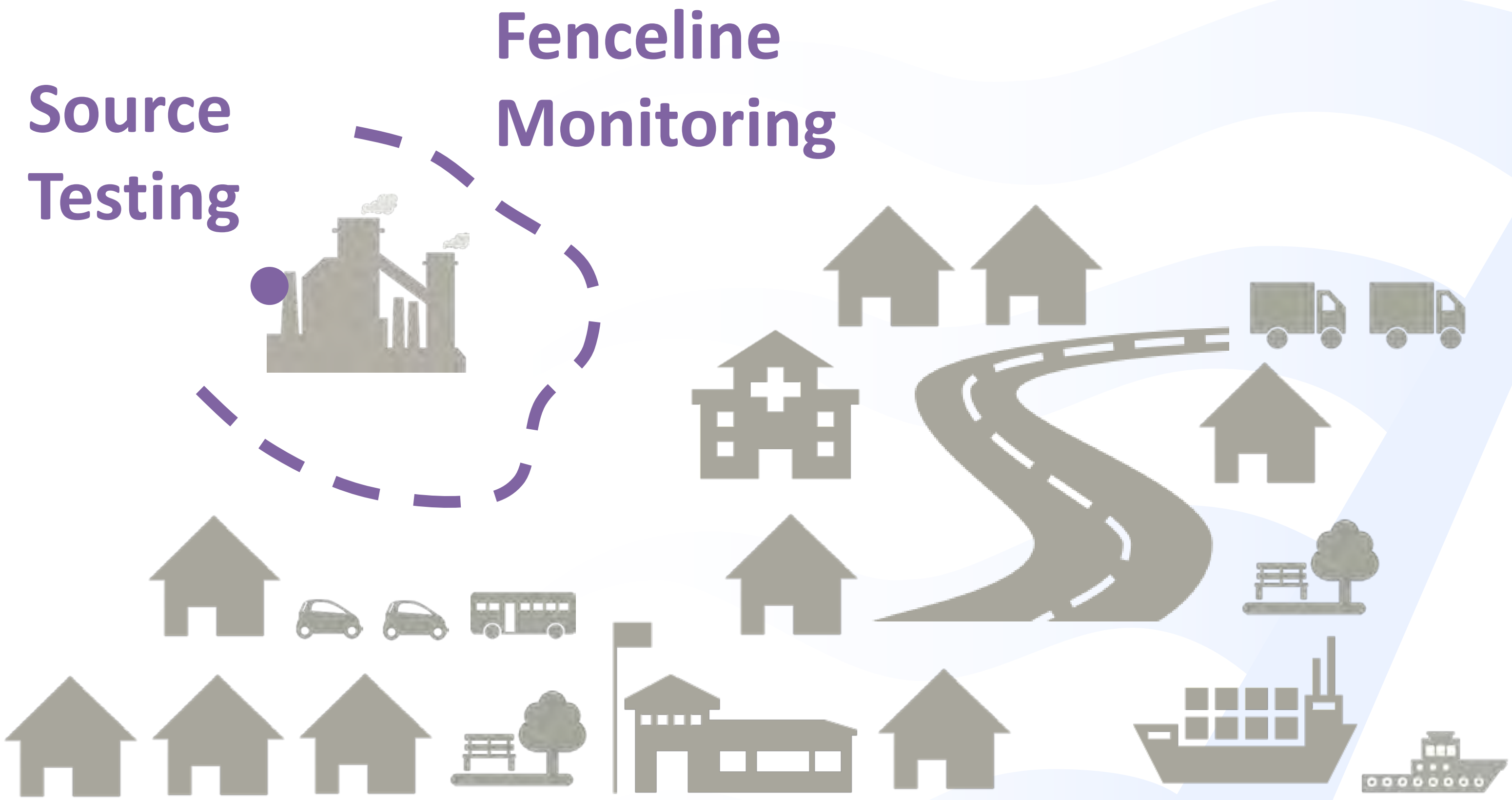
Monitoring

Ranyee Chiang
Director of Meteorology & Measurements

Advisory Council Meeting
December 9, 2019

Measurements in the Bay Area

Measurements in the Bay Area (cont.)



Measurements in the Bay Area (cont.)

Measurements in the Bay Area (cont.)

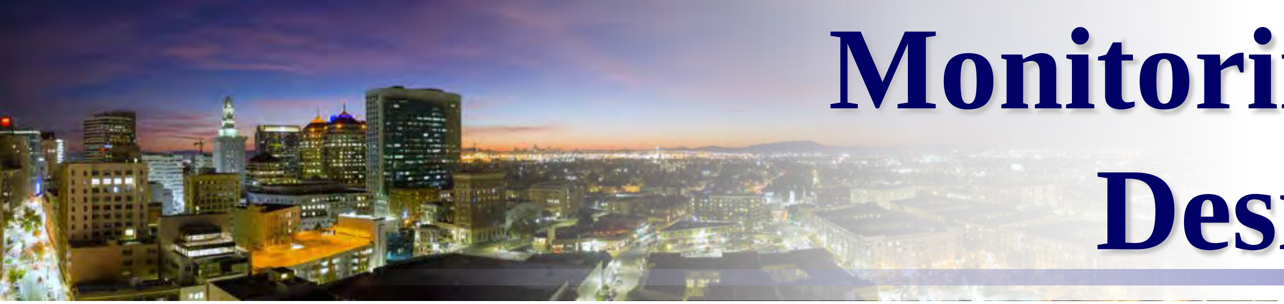
Sensor Networks

Outline: PM Monitoring

- Regional Network and Community Monitoring
  - Current capabilities
  - New developments
- What does the data show?
  - Ultrafine particles
  - Wildfire incidents
- Looking ahead
  - How could data be used
  - Options to strengthen air quality monitoring

Regional/Regulatory Network: Objectives

- Provide timely ambient air quality data to the general public
- Air quality forecasting for Spare the Air Program
- Support compliance with California and national ambient air quality standards
- Support air pollution research studies



Monitoring Network Design Criteria

- Site Types
  - Population-oriented
  - Highest concentration of pollutants
  - Source-oriented (downwind of major pollution sources)
  - General background sites
  - Regional transport (near borders of the Air District)

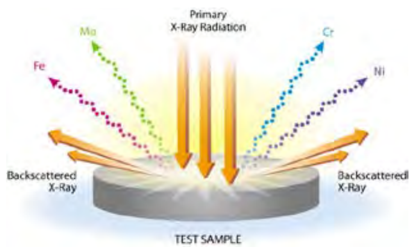
40 Code of Federal Regulations 58 Appendix D

- Based on population (2010 Census or estimates)
  - Number of monitoring sites in the Bay Area exceeds the required number

Particulate Matter (PM) Measurements

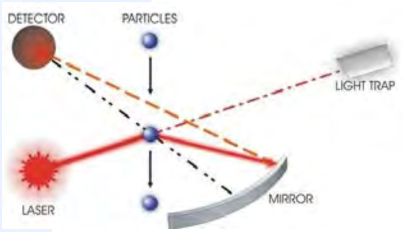
Mass Measurements

- Compliance with California and National PM_{10} and $PM_{2.5}$ standards
- Designate areas as attainment or nonattainment



Chemically Resolved or Speciated Data

- Support emission reduction strategies



Particle Counts

- Explore science on emissions, air quality impacts, and health effects associated with exposures

Air District PM Instrumentation

	PM_{10} Mass	$PM_{2.5}$ Mass	$PM_{2.5}$ Speciation	Ultrafine Particles ($PM_{0.1}$)	Black Carbon Mass
Analytical methods	Gravimetric	Gravimetric or Filter-based beta attenuation	Chemical extraction	Laser-based particle counter	Filter-based light attenuation
Active monitors	7	20	4	6	7
Example photo					

Ultrafine PM Monitoring

Strengths:

- 7+ years of experience with deployment in diverse siting applications
- Current data can be used to understand diurnal and seasonal patterns, trends, or differences between background, near-road, and typical urban settings

Limitations:

- Cost ($60k - $100K / unit)
- Instruments in PM-burdened areas require frequent maintenance
- Difficult to assess sources and sinks
- Data may not be robust enough to link to specific health impacts

New Developments: Hyperlocal, Street-by-Street Monitoring

- Partnership with Aclima to determine differences in air quality on a highly localized scale
- Sensor-based instrumentation (NOx, CO, O3, BC, PM2.5)
- Data reported through a public portal
- Began in Richmond-San Pablo in summer 2019; entire Bay Area within two years

Use cases:

- Empower communities with information about air quality typical of where they live and work
- Identify areas having elevated background concentrations for further investigation

New Developments: Mobile Laboratory

- High accuracy, real-time instrumentation to screen for PM and air toxics at a local scale
  - PM concentration
  - Inferred particle age
  - Size-binned measurements (ultrafine through PM_{10})
  - Black carbon
  - Potential to test for chemical components of PM in the future

Use cases:

- Identify and prioritize local sources of air toxics or PM
- Air quality between fixed-site monitors
- Identify locations for portable or fixed-site monitoring stations

New Developments: Portable Platforms

- High quality, battery powered, filter-based PM samplers that are relocatable
- Self-contained “suitcase” for continuous, real-time measurements using high quality, low power instruments

Use cases:

- Concentration variations throughout the day or week near an identified PM hotspot
- Measure air quality when the power is out due to high winds and fire hazard
- Verify low-cost sensor nodes

Outline: PM Monitoring

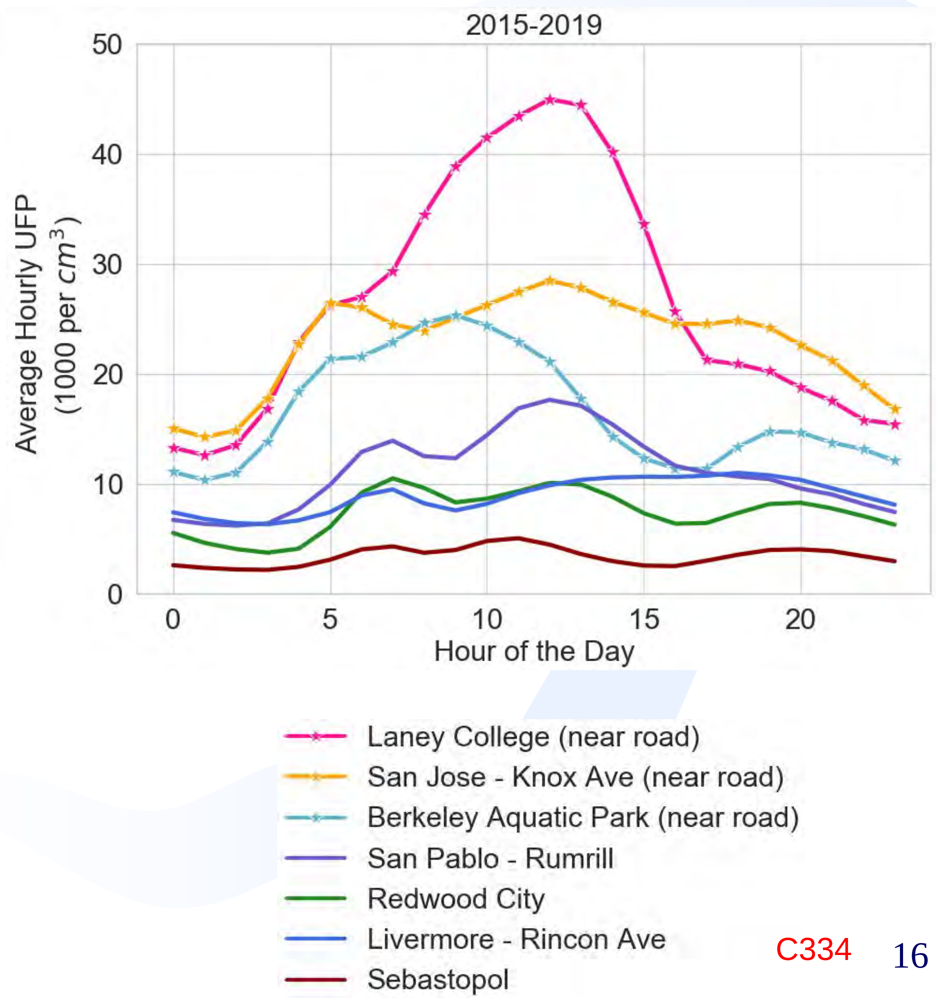
- Regional Network and Community Monitoring
  – Current capabilities
  – New developments
- What does the data show?
  – Ultrafine particles
  – Wildfire incidents
- Looking ahead
  – How could data be used
  – Options to strengthen air quality monitoring

What Do the Ultrafine Particulate (UFP) Data Show?

Levels influenced by traffic and/or photochemical reactions

- UFP highest at near-road sites
- Some sites consistently low, while others vary

Patterns of UFP throughout region differ from $PM_{2.5}$



C334

Wildfire Smoke Dramatically Affects Bay Area $PM_{2.5}$ Levels

Air District's Strategy to Reduce Impacts from Wildfire Smoke

Communication with the public

- Issue smoke advisories and Spare the Air alerts based on air quality forecasts
- Understanding air quality measurements and data
- How to reduce exposure during smoke impacts

Grants and incentives for recovery assistance

Work with other Air Districts and Public Health Officers

- Consistent wildfire health information
- Provide guidance for schools

Outline: PM Monitoring

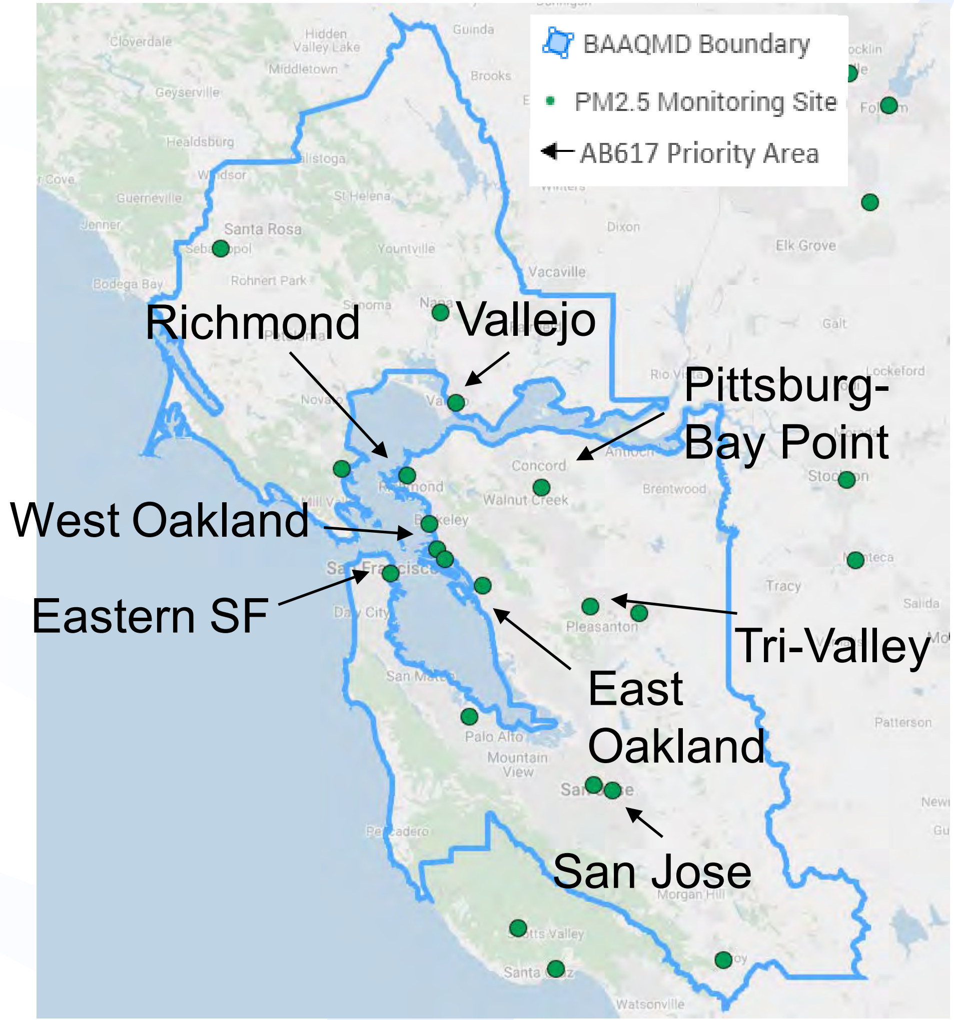
- Regional Network and Community Monitoring
  - Current capabilities
  - New developments
- What does the data show?
  - Ultrafine particles
  - Wildfire incidents
- Looking ahead
  - How could data be used
  - Options to strengthen air quality monitoring

Combining Monitoring Strategies for Multiple Objectives

Network	Measurements	Network Objectives
Regional Network	- $PM_{2.5}$ and PM_{10} Mass	- Comparison with health-based standards - Public information - Track long-term trends - Assess out of area transport
Special Projects (fixed site, portable, or mobile)	- PM size distribution - PM speciation - UFP - Black Carbon	- Source identification - Assessment of specific emission sources - Characterization of near-road environments
Sensor Networks (mobile or fixed)	- PM Mass - Particle Count	- More challenging to interpret due to higher levels of uncertainty - Public education - Personal exposure - Identification of hot-spots - Comparative assessment of local air quality - Tracking high PM episodes

Integrated PM Network Assessment (to be completed by July 2020)

- Evaluate PM measurement network to recommend improvements with available resources
- Address existing requirements and goals
  - Federal and state requirements
  - Understand criteria pollutant levels
- Strengthen network to address gaps
  - Incorporate multiple monitoring approaches
  - Support community air monitoring activities
  - Provide data to support other Air District activities



AGENDA: 5C

BAY AREA
AIR QUALITY
MANAGEMENT
DISTRICT

Update on Particulate Matter (PM) Air District Work:

Air District Grant Programs Overview

Karen Schkolnick
Strategic Incentives Division Director

Advisory Council Meeting
December 9, 2019

Overview

- Background
- Grants Overview and Priorities
  - Project Evaluation
  - Eligible Projects
- Supporting Air District Initiatives
- Results and Highlights
- Next Steps

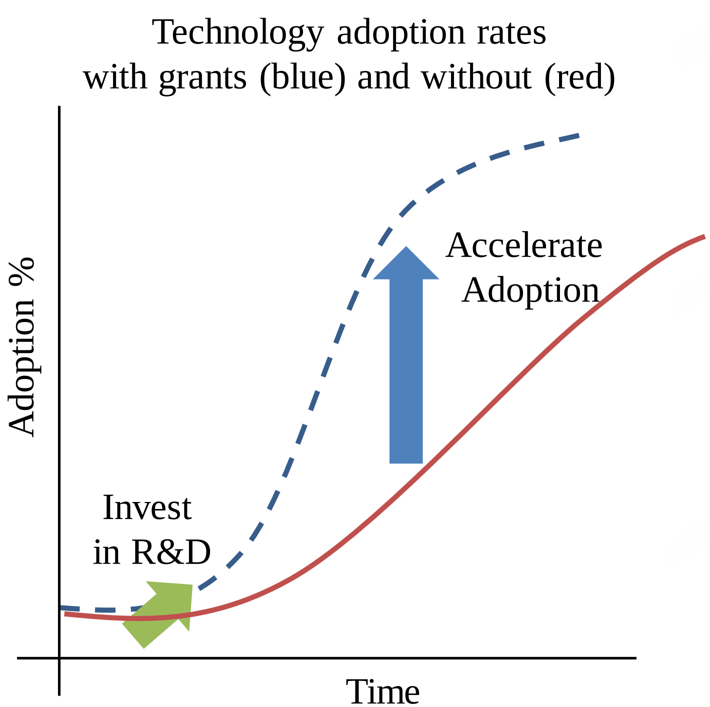
Background

Monitoring
Planning
Regulations &
Enforcement

Education
&
Outreach

Grants
&
Loans

Grants Overview and Priorities



- Cost-effective air quality and climate protection benefits
- Accelerated adoption of cleanest commercially available technologies and investments in R&D
- Expedited emissions reductions in disproportionately impacted communities

Project Evaluation
Cost-Effectiveness (CE)

$$CE = \frac{Funds\ Awarded}{Tons\ of\ NOx + ROG + (\boldsymbol{PM_{10}\ x\ 20})\ reduced}$$

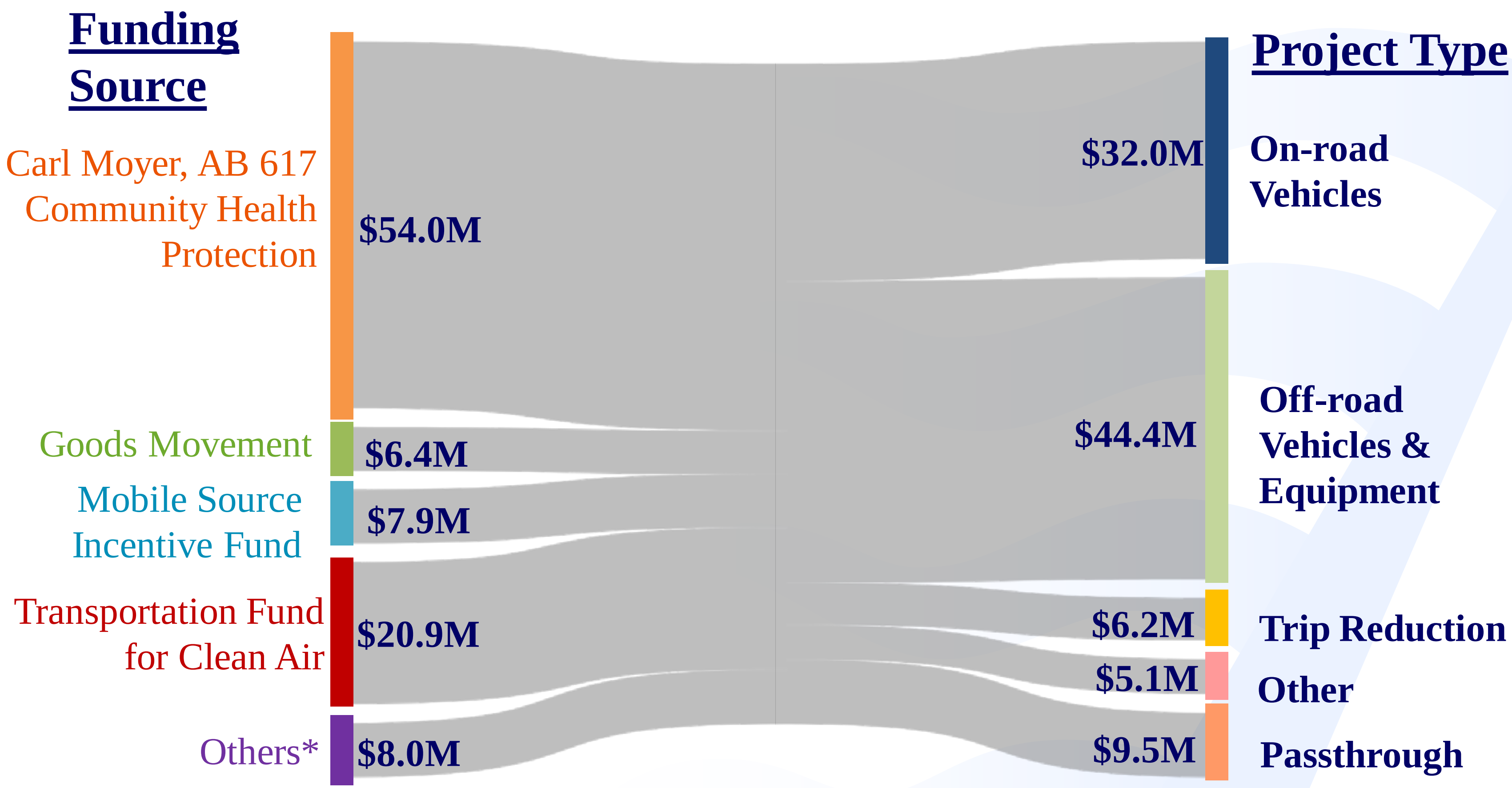
CE* estimates ***quantifiable,***

verifiable,

and surplus lifetime emission reductions

**CE formula is provided by CARB Carl Moyer Program Guidelines*

>$97M Awarded in 2018 to Eligible Projects



* Other funding sources include U.S. EPA's DERA, California Climate Investments, & Air District's general fund

Eligible Projects
On-road Vehicles

$32.0M

On-road Vehicles

Cars & Charging Stations	Trucks	Buses

Eligible Projects

Off-road Vehicles & Equipment

$44.4M

Off-road Vehicles And Equipment

Cargo Equipment

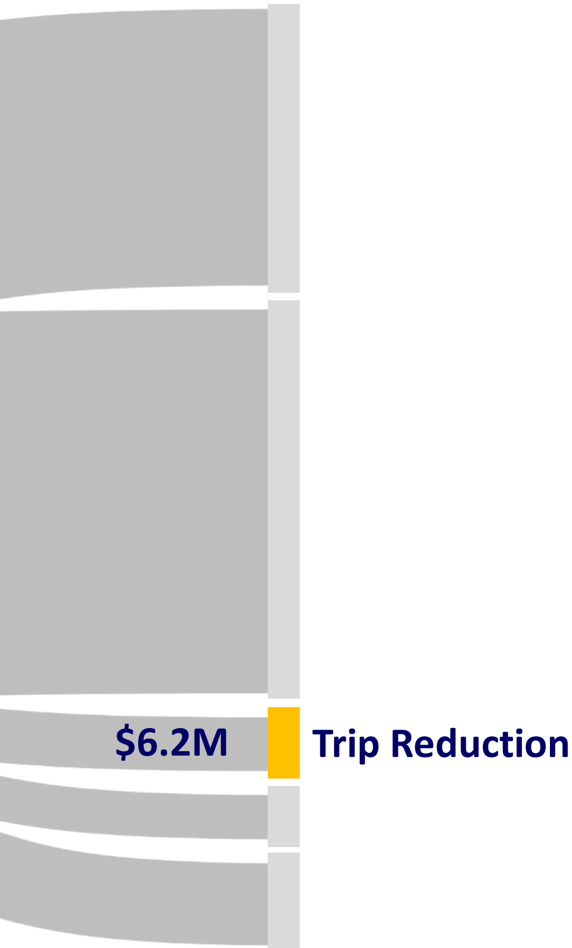
Ag Equipment

Marine & Locomotive

Other Off-road

C347

Eligible Projects
Trip Reduction

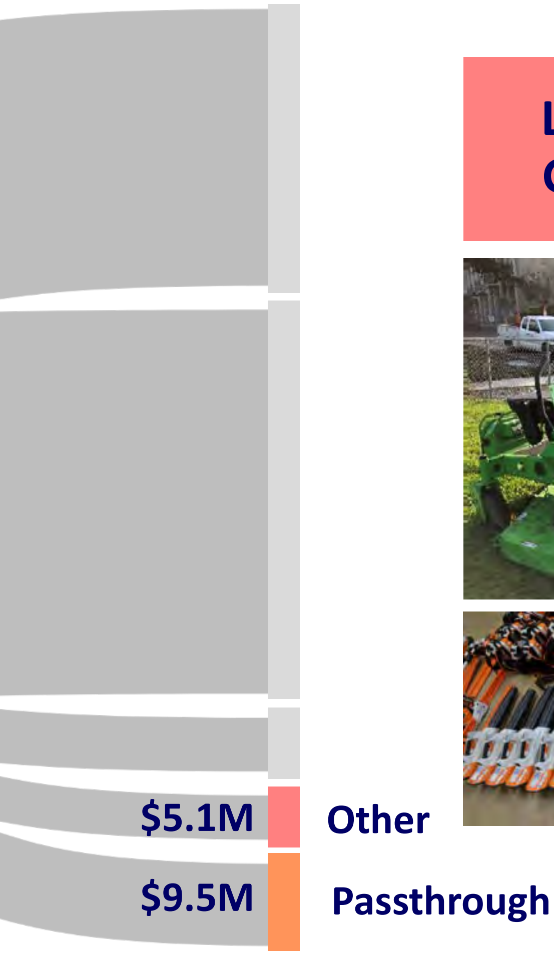


Shuttles & Ridesharing

Pilot Services

Bicycle Projects

Eligible Projects
Other & Passthrough



Lawn & Garden

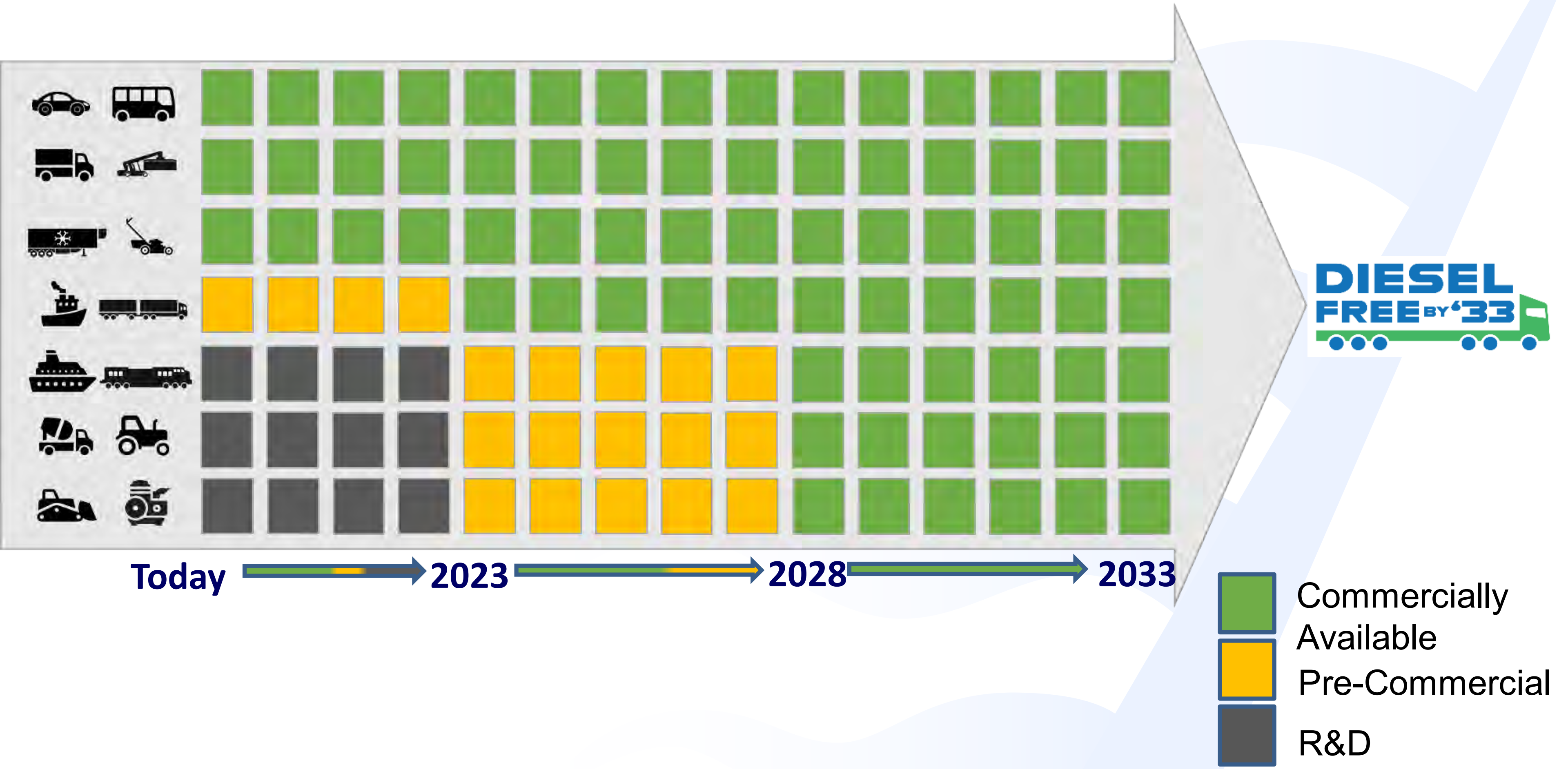
Wood Smoke

Climate Protection

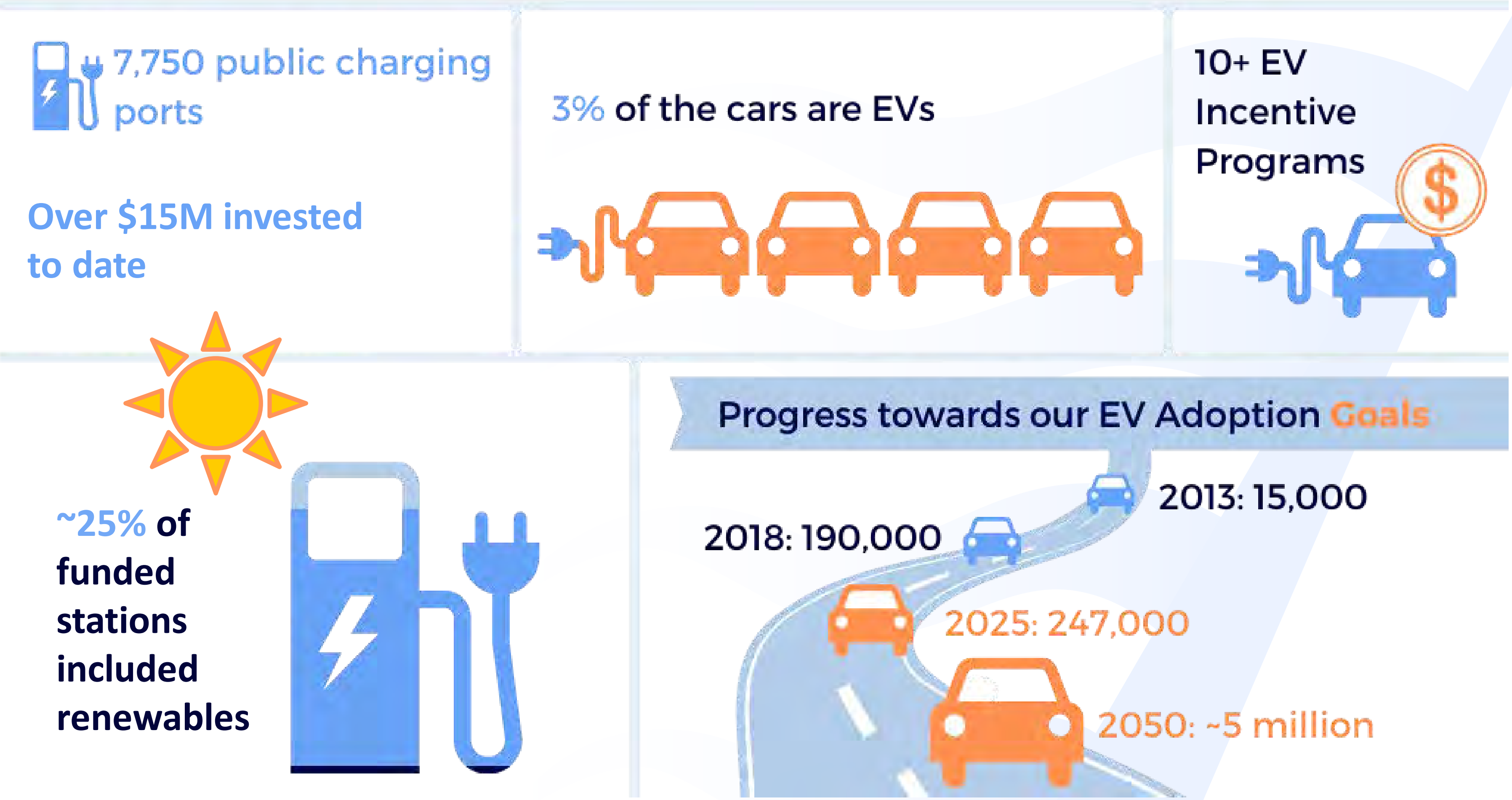
County Programs

Supporting Air District Initiatives

Path to Diesel Free by '33



Supporting Air District Initiatives
Bay Area Electric Vehicle Trends & Goals



Supporting Air District Initiatives

Advanced Technology Demonstrations

$2.9M to deploy 11 electric trucks & haulers for commercial delivery service

Goodwill
SAN FRANCISCO | SAN MATEO | MARIN

BYD

cte

CALIFORNIA CLIMATE INVESTMENTS
Cap and Trade Dollars at Work

$3M to deploy hydrogen-powered ferry for passenger service

RED AND WHITE FLEET SINCE 1892 SAN FRANCISCO CRUISES

HYDROGENICS
SHIFT POWER | ENERGIZE YOUR WORLD

CALIFORNIA CLIMATE INVESTMENTS
Cap and Trade Dollars at Work

CALIFORNIA AIR RESOURCES BOARD

MARITIME ADMINISTRATION 1950 UNITED STATES OF AMERICA

GOLDEN GATE ZERO EMISSION MARINE

Sandia National Laboratories

BAY SHIP & YACHT CO.

BAE SYSTEMS

Supporting Air District Initiatives

Early Emissions Reductions at Port of Oakland

Equipment Type	*DPM Inventory (tons)	
	2005	2017
Oceangoing Vessels	208.5	42.2
Harbor Craft	13.4	6.1
Cargo Handling Equipment	21.2	1.6
Trucks	15.9	0.3
Locomotives	2.0	0.3
Other	--	0.3
Total	**261**	**51**

>$100M in grants invested at Port of Oakland including:

- Retrofitted/replaced <1,900 drayage trucks
- Installed shorepower at 14 berths
- Replaced >1,090 on-road trucks

*Diesel Particulate Matter

Results and Highlights

Regionwide Cumulative Emissions Reduced (tons) Since 2015

ROG	NOx	PM_{10}	CO_2
1,329	3,237	359	576,899

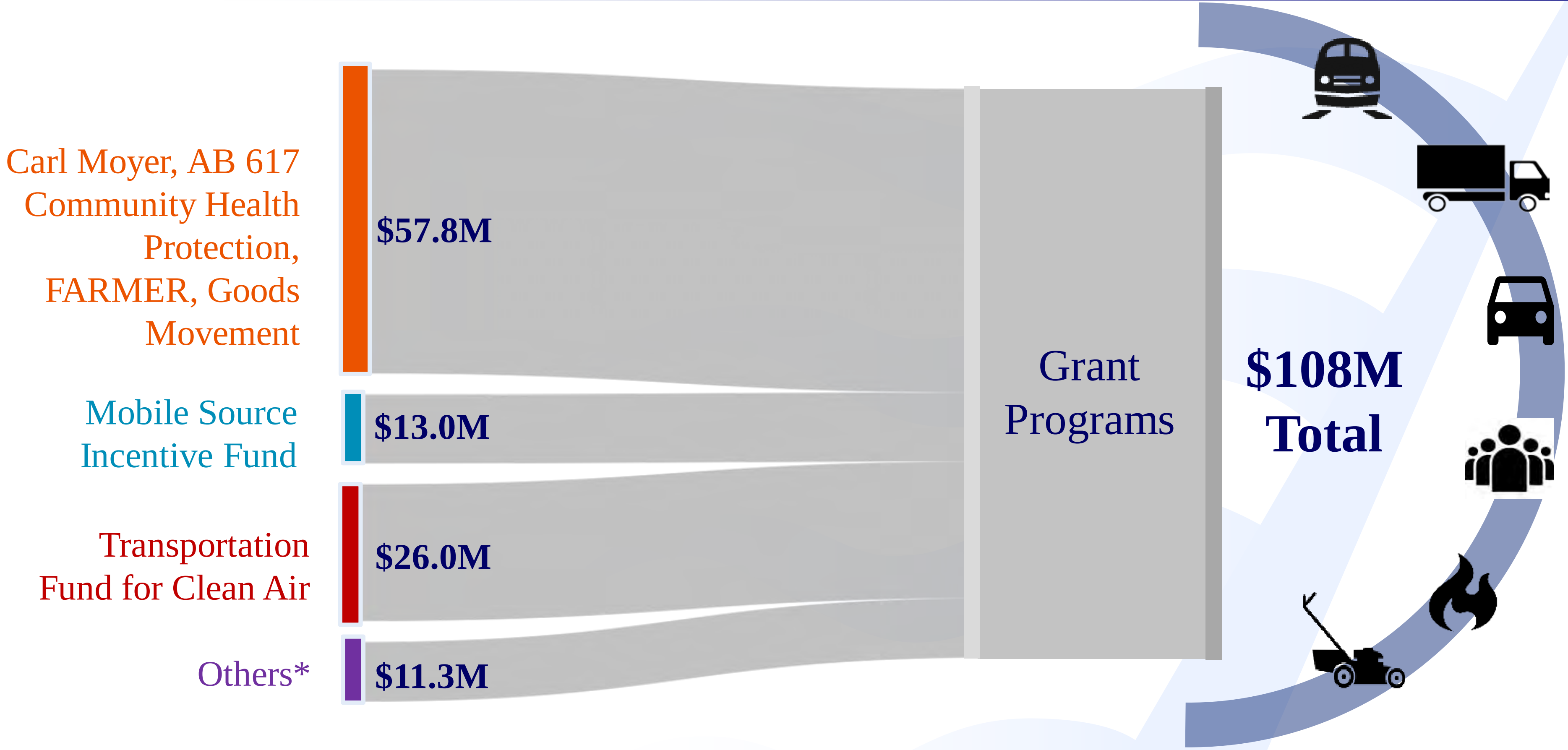
Highlights 2015 - 2019

- **1,000+** EV charging stations
- **~40 miles** of bikeways
- **1,200+** woodstoves and fireplaces
- **>100** ZE transit and school buses

53% of funds in CARE areas

Next Steps

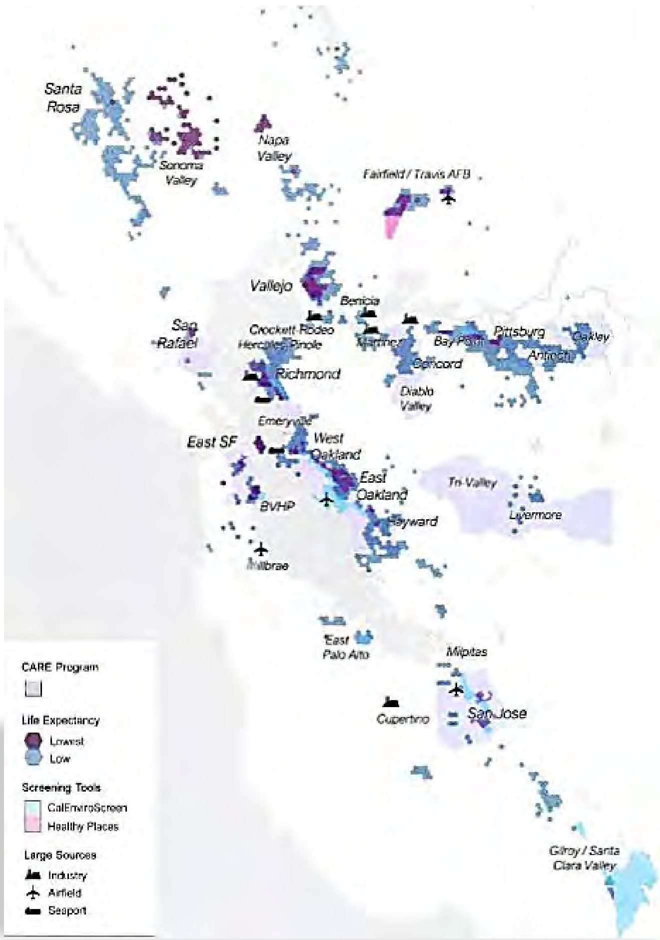
Incentive Revenues for 2020 (in millions)



* Others include Clean Cars for All and Climate Tech Finance (loan guarantee)

Next Steps

New & Expanded Grant Programs



- Secure new sources of funding
- Expand eligibility and initiate new programs
  - Expediting public health benefits in disproportionately impacted areas
  - Prioritizing programs that provide co-benefits

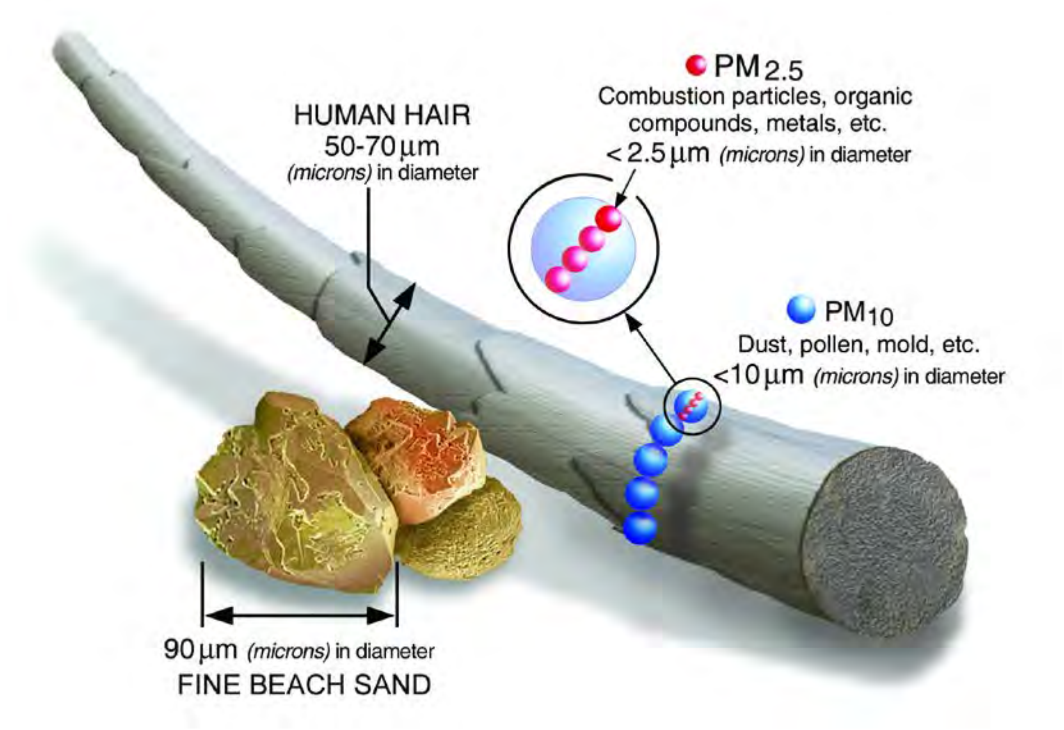
Particulate Matter Exposure
CARB Health Research and Rule

Álvaro Alvarado
California Air Resources Board
December 9, 2019

PM Exposure is an Important Public Health Concern

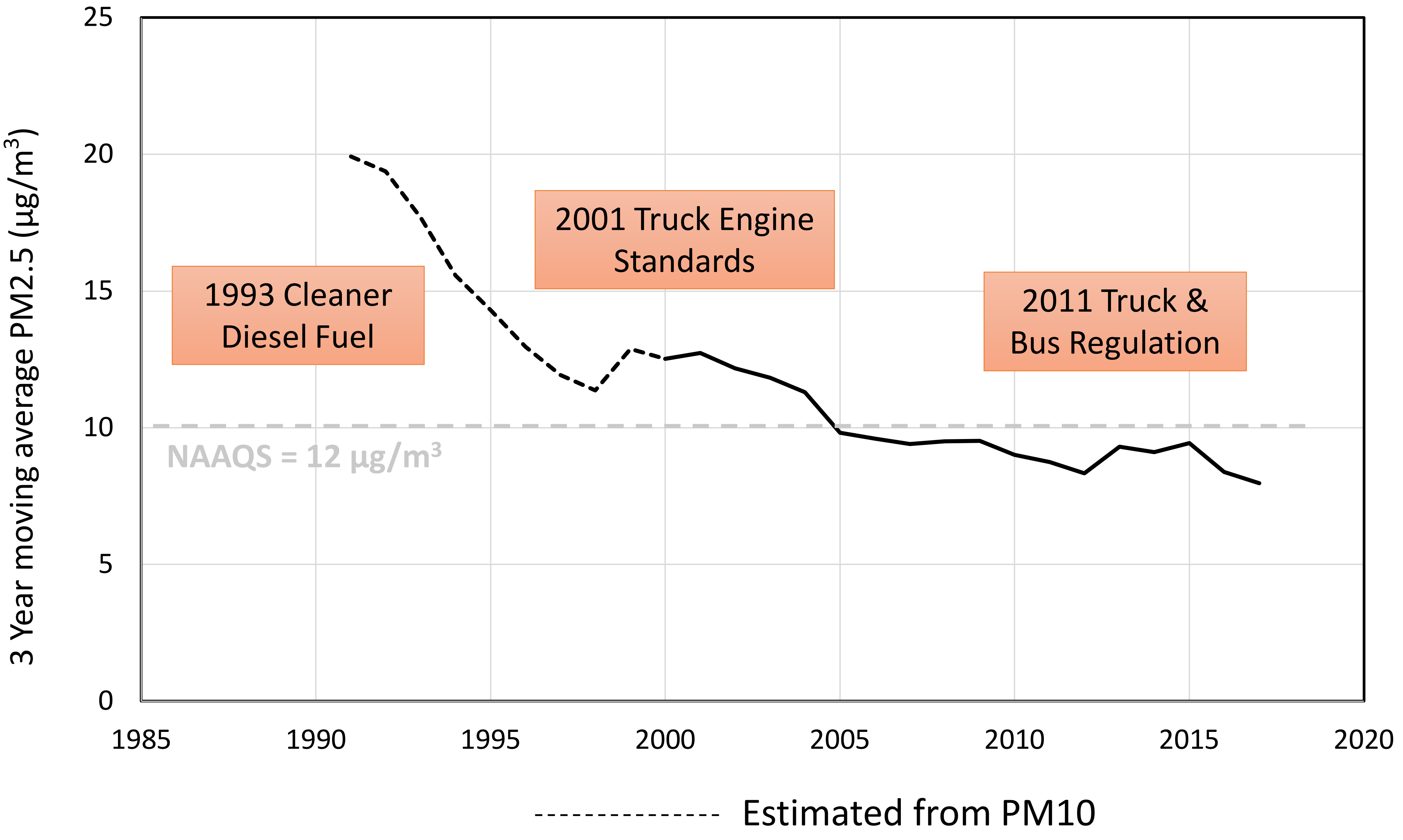
- Why are we concerned about PM?
  - Lots of evidence for health impacts
- If PM2.5 ↓ to background levels, could prevent (annually) about:
  - 7,200 premature deaths
  - 1,900 hospitalizations
  - 5,200 emergency room visits

But That's Not All – Additional Evidence of PM's Negative Health Impacts



- Strong evidence for increased:
  - Asthma attacks
  - Respiratory symptoms
- Probable association with:
  - Work loss days
  - Restricted activity days
  - Adverse brain effects

PM2.5 Trend in the San Francisco Bay Area Air Basin



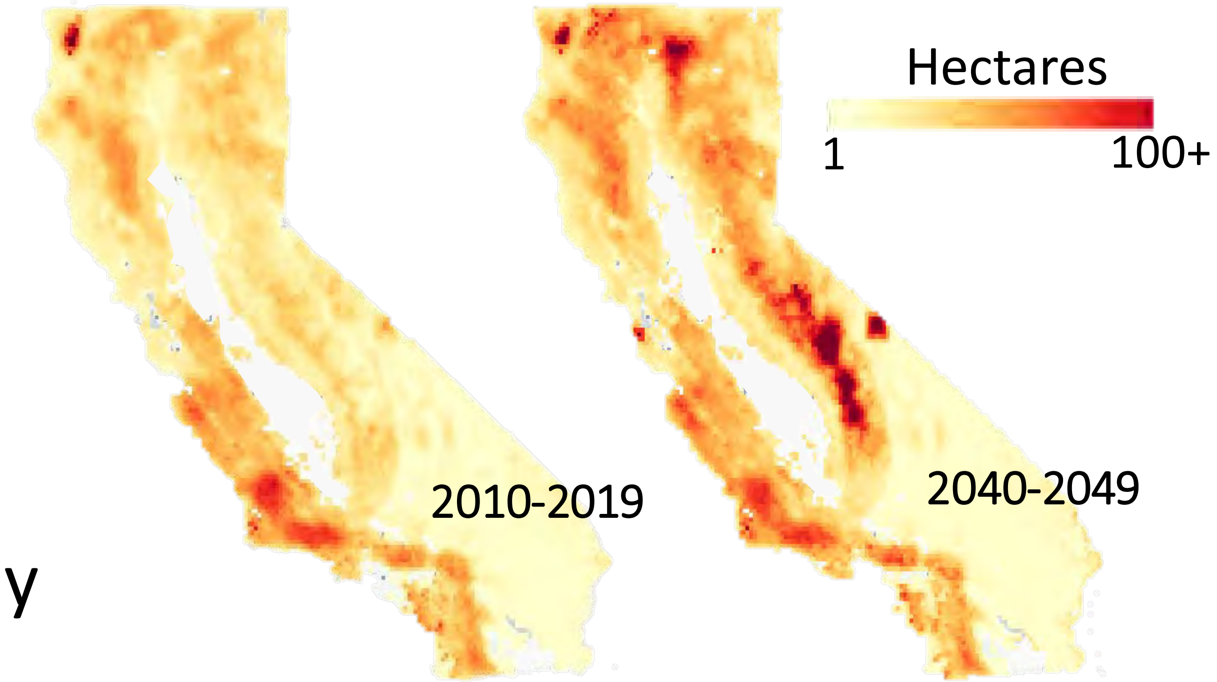
C360

CARB's Current Efforts and New Challenges

Wildfire-related PM Exposures

- Millions of Californians exposed to wildfires in 2018
- Wildfires: more frequent & intense with climate change
- Little known about health impacts
  - PM emitted during fire; post-fire ash
  - More structure/vehicle fires
- Particular concern: children & elderly

Forecast Average Annual Area Burned



Source: CalAdapt.org

CARB Research: Wildfire Health Impacts in Rhesus Macaques

- Infant monkeys in outside enclosures unintentionally exposed to wildfire smoke (Miller, UC Davis)
- As adolescents & young adults:
  - Impaired immune function
  - Changes in lung structure
  - Reduced lung function
  - Changes passed to next generation

CARB Research, in progress: Wildfire Emissions

- Understanding and mitigating wildfire risks (Goldstein, UC Berkeley)
  - Mobile measurements (in-house research with UC Berkeley & UC Riverside)
- NASA aircraft: investigating wildfire emissions & downwind air quality (Blake, UC Irvine)

PM from Brake & Tire Wear

- Successful reduction of regional PM from vehicle exhaust
- Vehicle tailpipe emissions most important regionally
- Non-tailpipe emissions may have localized importance
- Uncertainties in emissions & health impacts

CARB Research, in progress: Brake & Tire Wear

- Quantifying brake & tire wear emissions (Kishan, Eastern Research Group)
- Examining real-world brake & tire emissions and exposure to downwind communities (Jung, UC Riverside)
- In-house laboratory research projects
- Understanding potential health impacts (Jerrett, UCLA)

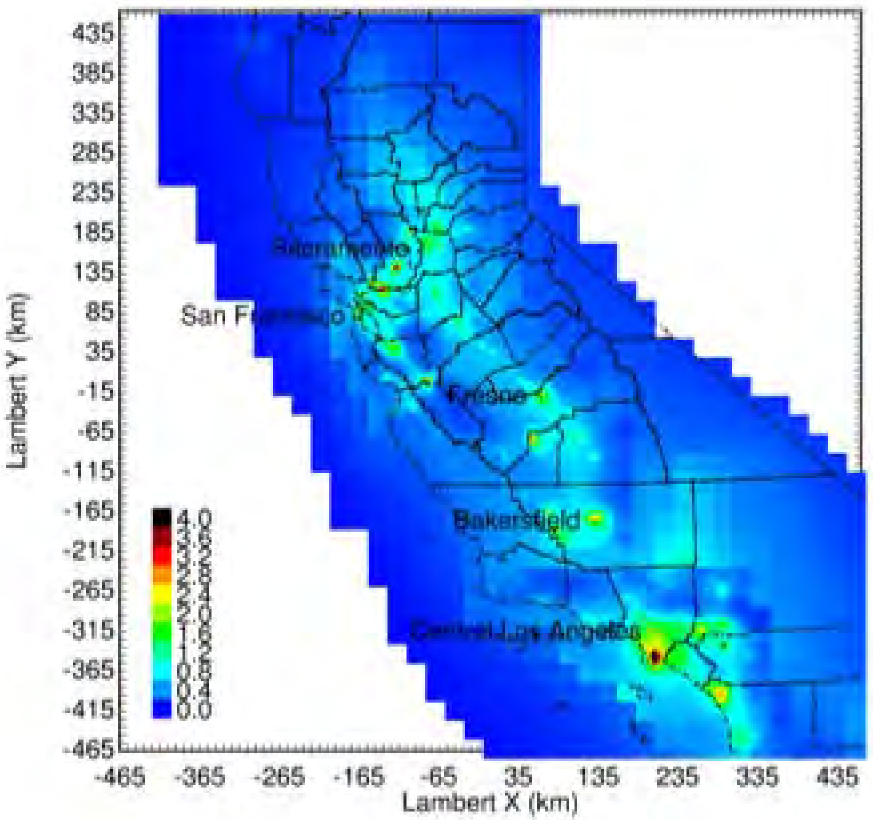
Health Risk from Ultrafine PM (UFPM)

- Potential exposure risks:
  - High numbers & chemicals attach to surface
  - Once inhaled, can go deep into lung
  - Can enter bloodstream, travel to organs
  - UFPM highly variable (space & time)
  - Sparse historical data

CARB Research: Health Effects of UFPM

- Monitoring, modeling, and health impacts of UFPM (Kleeman, UC Davis)
- Preliminary results suggest increased risk of premature death with higher exposure

Ultrafine Mass Concentration



CARB Research, in progress: Short-term PM Exposure

- White paper: reviewing short-term PM exposure impacts (Kleinman, UC Irvine; in progress)
- Air monitoring in AB 617 communities
    - Localized pollutant exposures
- Determine if need to address short-term exposures

Statewide Mobile Source Strategies Overview

Heavy Duty Trucks

Warehouses

Passenger Cars

Trains

Heavy Duty Trucks

- Advanced Clean Trucks regulation
- Heavy-duty vehicle inspection and maintenance
- Innovative Clean Transport
- Airport Shuttles
- Low NOx Omnibus Rule

Warehouses

- Freight Handbook
- Transport refrigeration unit regulations
- Drayage truck regulation amendments
- Cargo handling equipment amendment

Passenger Cars

- Advanced Clean Cars 2
- Catalytic converter theft reduction

Trains

- Reduce idling for all rail yard sources
- Potential development of regulation to reduce emissions for locomotives

Thank you

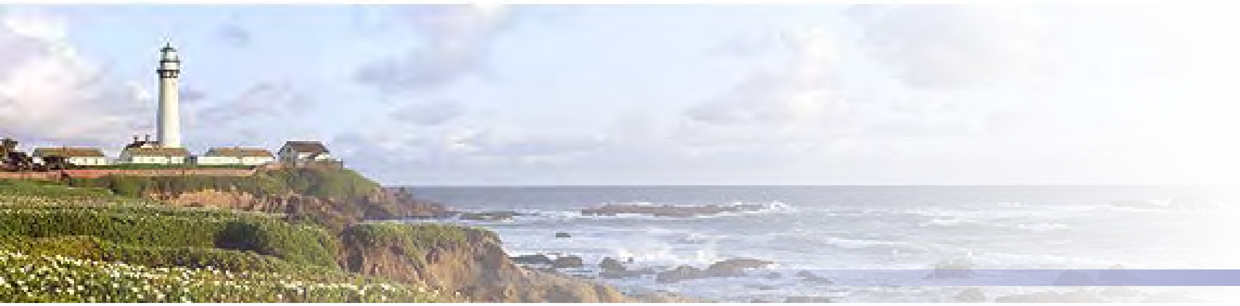
BAY AREA AIR QUALITY MANAGEMENT DISTRICT

Update on Particulate Matter (PM) Air District Work:

PM Rules and Regulatory Development

Victor Douglas
Rule Development Manager

Advisory Council Meeting
December 9, 2019

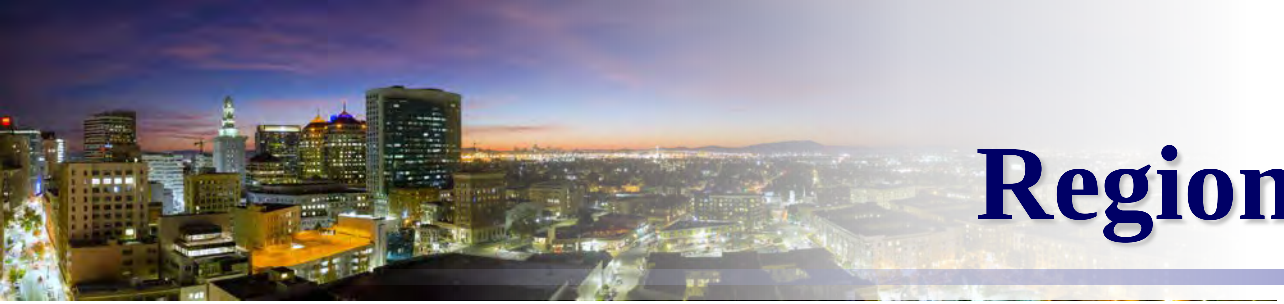


Overview

- Approaches to Regulate PM
- PM Rules and Regulations
- Current and Future Efforts
  - Regional attainment
  - Localized impacts
  - Gap analysis

Regulation of PM

- Three Ways to Regulate PM:
  1. Originally regulated as a Nuisance
     - Open burning (original Reg 1)
     - Dust and aerosol (original Reg 2)
  2. Criteria (i.e., regional)
  3. Toxic (i.e., local/community level)
     - Diesel PM



Regional Approach

- Attainment of ambient air quality standards
- Control of Primary PM
  - Filterable
  - Condensable
- Control of Secondary PM
  - Oxides of Nitrogen (NOx)
  - Sulfur Dioxide (SO_2)

PM Rules & Regulations

- Regulation 2: Permits
- Regulation 5: Open Burning
- Regulation 6: Particulate Matter
- Regulation 9: Inorganic Gaseous Pollutants
- Regulation 11: Hazardous Pollutants
- Regulation 12: Miscellaneous Standards of Performance

PM Rulemaking Efforts

- 2012 – **Rule 2-2 amendments** to add New Source Review permitting requirements for $PM_{2.5}$
- 2012 – **New Rule 9-13** to reduce PM emissions from Portland cement kilns
- 2013 – **New Rule 6-4** and **new Rule 12-13** to reduce PM emissions from metal foundries and shredding facilities

PM Rulemaking Efforts

- 2015 – **Rule 6-3 amendments** to further reduce wood smoke from wood-burning devices
- 2016 – **New Rule 9-14** to reduce precursors of secondary PM from petroleum coke calcining operations
- 2018 – **New Regulation 6**, **new Rule 6-6**, and **Rule 6-1 amendments** to reduce PM emissions from fugitive dust sources
- 2019 – **Rule 6-3** to extend No Burn Days for the Wildfire Response Program

2018 PM Rules

- New Regulation 6 for common definitions and test methods
- New Rule 6-6 for prohibition of trackout
- Rule 6-1 amendments for general requirements and bulk material handling
- Reduce PM emissions from fugitive dust sources
- Expected emission reductions of 1.6 tpd PM_{10}, 0.2 tpd $PM_{2.5}$

Current and Future Efforts

- Continued **regional** efforts on further PM reductions (e.g., Rule 6-5: PM from FCCUs)
- Source categories and rule efforts identified in planning efforts
- Additional areas from gap analysis
  – Restaurants
  – Wood smoke
  – Indirect and magnet sources
  – PM as a toxic pollutant

Current and Future Efforts (cont.)

- To address **localized** PM issues
- Regulatory framework for site-specific localized PM impacts
- Existing localized approaches for toxics
  – Air District Rule 11-18 for Air Toxic Emissions from Existing Facilities
  – AB 2588 Air Toxic Hot Spots Program

Discussion

Questions?

Discussion Questions

Are current PM standards sufficiently health protective?

Are some species of PM more dangerous than others?

What is role of ultrafine particles (UFPs)?

Should form of target expand to account for more than just mass?

How should we include draft PM ISA's new "likely-causal" health endpoints (nervous system effects, cancer) and new more sensitive populations (children, lower socio-economic status)?

What are health impacts of high-concentration acute events (e.g., wildfires)? How should we compare them to day-to-day PM impacts?

Discussion Questions

What are major sources of PM in the Bay Area?

What PM levels exist in Bay Area? What health risks do they pose?

How much additional health benefit can be achieved?

How should we account for spatial scale of effects (i.e., regional versus local-scale impacts, including proximity to major sources)?

How should we determine which measures would most move public health needle?

Deliberation Questions

What is bullseye in clean air target? How clean is clean enough?

How will we know when we get to target? What metrics should we use to track progress?

How do we combine criteria pollutants and toxics? Cancer and non-cancer health endpoints? Short- and long-term effects?

How can we make sure everyone is treated fairly?

How can we ensure that everyone breathes clean air?

What are most important actions that can be taken now? And, in future?

Discussion Questions (DRAFT)

Are current PM standards sufficiently health protective?

NOT SUFFICIENTLY PROTECTIVE; MORE STRINGENT STANDARDS NEEDED

Are some species of PM more dangerous than others?

QUITE POSSIBLY BUT NOT ENOUGH INFORMATION; NO PM COMPONENTS "EXONERATED" THOUGH

What is role of ultrafine particles (UFPs)?

NOT YET CLEAR, BUT TOX STUDIES OF CONCERN; NEED UFP FEDERAL REFERENCE METHOD; MORE MONITORING; EPI STUDIES NEEDED

Should PM "target" expand to account for more than just mass?

IN RESEARCH, ABSOLUTELY; IN REGULATION, TOO SOON, UNLESS HIGHLY RISK-AVERSE

How should we include draft PM ISA's new "likely-causal" health endpoints (nervous system effects, cancer) and new more sensitive populations (children, lower socio-economic status)?

STRONGER EVIDENCE, NEW HEALTH EFFECTS; GROWING RECOGNITION OF "AT RISK" GROUPS (E.G., CHILDREN AND LOW SES); NEED TO CONSIDER

What are health impacts of high-concentration acute events (e.g., wildfires)? How should we compare them to day-to-day PM impacts?

NOT WELL-KNOWN SCIENTIFICALLY, BUT OF CONCERN; DATA ON SUB-DAILY EXPOSURES TOO LIMITED AS YET; POTENTIALLY SERIOUS EFFECTS REPORTED IN EARLY STUDIES; NEW STUDIES ONGOING; MORE RESEARCH NEEDED

Discussion Questions (DRAFT)

What are major sources of PM in the Bay Area?

WEST OAKLAND: PM2.5, TOP 3 – PORT (17%), STREET (17%), HIGHWAY (16%);
DIESEL PM, TOP 3 – PORT (57%), STREET (7%), HIGHWAY (8%)

What PM levels exist in Bay Area? What health risks do they pose?

WEST OAKLAND: PM2.5 = 8.7 ug/m3 (ALL SOURCES, AVERAGE), LOCAL SOURCES = 1.5 to 2.2 ug/m3 (BY NEIGHBORHOOD);
DIESEL PM = 0.7 ug/m3 (AVERAGE);
HYPER-LOCAL HOT SPOTS COULD BE HIGHER

How much additional health benefit can be achieved?

REDUCING ANNUAL PM2.5 FROM 12 ug/m3 TO 10 ug/m3 COULD REDUCE RISK BY 10-15%; THOUSANDS FEWER DEATHS IN U.S. EACH YEAR

How should we account for spatial scale of effects (i.e., regional versus local-scale impacts, including proximity to major sources)?

SPATIAL SCALE IMPORTANT; REGIONAL- VS. LOCAL- VS. HYPER-LOCAL-SCALE IMPACTS
WEST OAKLAND: PM2.5 CONCENTRATION – OVERALL, 80% FROM REGIONAL SOURCES, 20% FROM LOCAL SOURCES;
DIESEL PM CONCENTATION – OVERALL, 40% FROM REGIONAL SOURCES, 60% FROM LOCAL SOURCES; HYPER-LOCALIZED HOT SPOTS COULD BE HIGHER

How should we determine which measures would most move public health needle?

NEED MORE SCIENCE, AND NEED TO ACT NOW; OPTIONS TO BE DETERMINED; DISTRICT STAFF TO IDENTIFY

Deliberation Questions (DRAFT)

What is bullseye in clean air target? How clean is clean enough?

XXX

How will we know when we get to target? What metrics should we use to track progress?

XXX

How do we combine criteria pollutants and toxics? Cancer and non-cancer health endpoints? Short- and long-term effects?

XXX

How can we make sure everyone is treated fairly?

XXX

How can we ensure that everyone breathes clean air?

XXX

What are most important actions that can be taken now? And, in future?

XXX

SUMMARY: Community Particulate Matter Discussion February 27, 2020

NOTE: A full transcript of the event is available from the stenographer. This summary aims to capture key themes in advance of the submission date for background materials for the next PM Symposium.

Overview

Community members, grassroots organization leaders, and Air District staff members met at the Bobby Bowens Center in Richmond on the evening of February 27, 2020 to gather community input on particulate matter (PM) impacts, monitoring, and regulatory efforts. The event was organized by a Design Team of community leaders with assistance from Elinor Mattern of the Air District's Community Engagement Section. Approximately 30 people attended to express their concerns regarding PM, its sources, and its health effects.

Input from community members centered on the following issues:

<u>Localized PM data availability</u>
- Desire for data beyond West Oakland
- Desire for real-time, continuous, publicly accessible localized monitoring
- Consolidating/sharing community-collected data (e.g. PurpleAir)

<u>Toxicity of different PM species</u>
- Concerns regarding severity of problems from refineries and other permitted sources (e.g. cement plant, concrete crushers, metal processing facilities)
- Skepticism regarding wood burning as a major driver of health impacts

<u>Lack of observable results from prior rulemaking</u>
- 2017 Clean Air Plan
- Crude slate inventory
- General enforceability issues

<u>Potential for problems to worsen</u>
- Issuance of new permits
- Emerging indoor air concerns (e.g. vapor intrusion) beyond the scope of the Air District
- Climate impacts
- Lengthy time horizon prior to implementation (e.g. diesel PM rules took 10 years)

This summary provides a brief background on the event. Additional details regarding these community concerns and the Air District's clarifications in reply are noted in the transcript.

Background

The February Community Discussion in Richmond was part of a series of Bay Area events focused on health effects of PM. This series began in October of 2019 and will culminate in a set of findings from the Air District's Advisory Council to be delivered to the Air District Board. The Community Discussion preceded a planned symposium that was to be held in Oakland, originally scheduled for March 24th, 2020, but postponed due to COVID-19, at which representatives from local community organizations would present to the Advisory Council regarding local PM efforts, needs, and priorities. The purpose of the Community Discussion was to gather additional community input and engagement prior to that next Symposium.

The following community leaders worked together to organize the event with assistance from Elinor Mattern of the Air District's Community Engagement Section:

- Katherine Funes - New Voices Are Rising
- Richard Gray - 350 Marin
- Jed Holtzman - 350 Bay Area
- Ashley McClure - California Climate Health Now
- Steve Nadel - Sunflower Alliance
- Ken Szutu - Vallejo Citizen Air Monitoring Network
- LaDonna Williams - All Positives Possible

A list of community members who attended the event is provided in the attached Appendix, along with information on the missions of the organizations with which they are affiliated.

Structure

The gathering began at 5pm with informal sharing of a meal, followed by introductions from discussion facilitators Azibuike Akaba (Senior Public Information Officer, Air District) and Laura Neish (Executive Director, 350 Bay Area). Jed Holtzman (350 Bay Area) also offered welcoming remarks. Brief presentations by Air District staff preceded the discussion portion of the event:

- Goals of the PM Symposium Series (Greg Nudd)
- Major Sources of Fine Particulate Matter (Phil Martien)
- Current & Potential Rules to Reduce PM (Jacob Finkle)
- Policy Approaches for Particulate Matter (Victor Douglas)

Attendees asked questions and contributed comments following each presentation in addition to participating in the discussion portion of the gathering. Facilitators concluded the event at 8pm. The content of these exchanges is summarized thematically in the following section. Details on Air District presentations are omitted as this information is also being shared in the PM Symposia and details are recorded in the transcript of the Community Discussion.

Key Concerns Expressed by Community Members and Air District Replies

Localized PM data availability

"I think the public needs to have more access to what is going on."

Desire for data beyond West Oakland. Several community members expressed frustration with the repeated presentation of West Oakland information, as such information has not been provided for other areas. For some community members, this emphasis on West Oakland felt "disrespectful" to other communities.

Air District reply: The localized analysis piloted in West Oakland is a very new approach, so it requires cautious expansion. Vehicle-mounted monitors are in the process of collecting data for the entire Bay Area. Richmond data is now available. Information for other communities will be rolled out over the next couple of years.

Desire for real-time, continuous, publicly accessible localized monitoring. Community members seek the capability to access "readouts" in real time to determine local air quality, particularly in the presence of unusual odors or flares. Concerns were expressed regarding current monitoring accuracy, with the example given of normal readings following permitted-facility accidents. An additional concern was the perception that polluters are not required to pay for monitoring: "Currently all this cost falls onto the community and we don't have the money. And if we don't have the money we don't have the monitoring and the business pollutes freely."

Air District reply: Monitoring is continuous and publicly accessible but not in real time. The Air District hopes to move toward real-time monitoring, but presently both sample analysis and data analysis create lags. Permitted facilities are required to conduct and pay for their own monitoring, and the Air District performs tests to confirm the accuracy of that monitoring.

Consolidating/sharing community-collected data (e.g. PurpleAir). As organizations and community members have begun collecting air monitoring data themselves using technology such as PurpleAir, they are seeking a means of consolidating and sharing those data. Steve Nadel of the Sunflower Alliance asked whether the Air District is working on that effort.

Air District reply: There is a new third-party "Bay Air Center" (independent of the Air District) that will provide technical support for monitor selection and siting. The California Air Resources Board has agreed to centralize air quality sensor data through their grant program. This process is likely to be challenging.

Toxicity of different PM species

"Just presenting the percentages [from different sources] doesn't give the full picture of toxicity. Not all particulate matter is created equal."

Concerns regarding higher severity of PM health effects from permitted sources. Depiction of PM contributions from different sources as percentages of a total raised concerns for attendees who stated that some types of PM are more toxic than others. Many comments in the meeting focused on permitted sources, including oil refineries, metal processing facilities, and concrete crushers. Community representatives want to understand where the "fault lines" lie in terms of permitted facility PM fallout — for example, a community may be downwind of a refinery yet not be considered a "refinery community" depending on where boundaries are drawn.

Air District reply: Compounds that are known to be toxic (e.g. toxic metals) are independently tracked. However, there is insufficient information regarding the toxicity of undifferentiated PM, which is why the Air District takes a precautionary approach assuming all PM to be highly hazardous. Regarding impacts from permitted facilities, studies are currently being conducted by the Air District to better understand PM emissions from refineries and to track exposures from local sources of PM in disproportionately burdened communities. Additionally, new rules regarding fluidized catalytic cracking units are in the final stages of development. With respect to the East Oakland AB&I metal foundry, the Air District is involved in resolving issues with Rules 11-18 and 12-13 regarding air toxics and PM.

Skepticism regarding wood burning as a major driver of health impacts. A significant amount of skepticism was expressed by community members regarding wood burning as a leading PM health issue. Air District measurement and monitoring methods were questioned. There was apparent frustration with the implied equating of wood smoke to refinery smoke.

Note: A community member who was not able to be present at the gathering, Richard Gray of 350 Bay Area, stated upon reading the transcript that in the San Geronimo area where he lives residential wood burning does have a substantial negative impact on air quality. He expressed that certain weather patterns can cause this wood smoke to remain in the immediate area rather than dissipate, and that problems associated with that smoke exposure have prompted numerous residents to relocate.

Air District reply: Data collection on wood burning involves not only surveys and modeling but also filter analysis to reveal the components of localized PM: "We can tell what is on those filters and what fraction is from wood burning." However, it is expected that wood burning is more prevalent in some areas than others, which will be clarified in the forthcoming community-level studies. Current science indicates that wood smoke is highly toxic.

Lack of observable results from prior rulemaking

"It seems like implementation is a problem."

2017 Clean Air Plan. Jed Holtzman of 350 Bay Area stated that many of the solutions that the Air District is currently presenting were already in the 2017 Clean Air Plan and asked what institutional constraints are preventing implementation. He also described an existing rule requiring facilities to conduct health impact assessments and stated that two and a half years after the rule had been developed this is still not happening.

Air District reply: New approaches are being implemented to speed up the process. This PM Symposium Series is designed to ensure that the full impact of PM — as reflected in the science and the community — is clear to decision makers. In addition to the health costs, the economic costs of PM are being calculated in order to further incentivize action. Additionally, the Air District is pursuing innovative means of clarifying jurisdiction for local sources of PM, such as "magnet sources" like warehouses that attract truck traffic.

Crude slate inventory. Rule 12-15, requiring accurate crude inventories, was brought up by Shoshana Wechsler of 350 Bay Area/Sunflower Alliance, who asked for the status of this data.

Air District reply: There have been some reporting difficulties because legal constraints prevented the Air District from specifying formats for data collection. A means of requiring standardized reporting has now been identified and this information will soon be available.

General enforceability issues. Several issues with enforceability were raised, such as lack of moisture content measurement at construction sites to limit dust, and citations of violations being limited to "visibility" issues following fires at permitted facilities. Ken Szutu of the Vallejo Citizen Air Monitoring Network suggested that perhaps rather than arranging community meetings with the Air District's rulemaking teams, these meetings should be centered on the departments responsible for enforcement.

Air District reply: The Air District does not have "police powers." The enforcement process is carried out by the District Attorney. The Air District strives to work collaboratively with permitted facilities to ensure compliance.

Potential for problems to worsen

"You can't stop the cold air coming in if you close a window on one end and then open a different one on the other."

New permits continue to be issued. Much attendee support was expressed for a comment from LaDonna Williams of All Positives Possible that, despite all the discussion about reducing emissions, the Air District continues to issue permits to new sources.

Air District reply: The Air District is statutorily obligated to issue permits. However, the aim is to put the brakes on emissions in areas that are already overburdened. The Air District is developing an approach intended to consider existing PM exposures in the community in order to ensure that burden is not increased.

Emerging indoor air concerns. Residents are experiencing problems with toxic vapor intrusion of polychlorinated biphenyl (PCB) and trichlorobenzene (TCB) compounds in their water delivery systems. They asked how the Air District can help.

Air District reply: Although household indoor air is not within its authority, the Air District is seeking to collaborate with the Water Control Board and will be involved in a multi-agency workshop to try to speed resolution of this problem.

Climate impacts. A community member inquired about the connection between the health impacts under discussion and the public health threat of the climate crisis.

Air District reply: The 2017 Clean Air Plan demonstrates the linkages, with one of its three pillars focusing on health.

Lengthy time horizon prior to changes being implemented. Citing the example of diesel PM rulemaking taking 10 years, concern was expressed that the present process may be many years away from producing meaningful change: "How do we compress that?"

Air District reply: With the Board's buy-in, we can start working on elements of our strategy without having to wait years. We are working to compress that timeline.

APPENDIX - Attendee List for Community Particulate Matter Discussion – 2/27/2020

Organization	Representative(s) Attending (+ Organizational Role)	Website	Notes on Organization Mission (based on websites)
350 Bay Area	Jed Holtzman (Senior Policy Analyst)	https://350bayarea.org/	Bay Area organization supporting policies that promote clean energy, eliminate fossil fuels, and facilitate just and socially equitable solutions to ensure a livable planet for future generations.
350 Contra Costa	Jackie García	https://350bayarea.org/350contracosta	Contra Costa team of 350 Bay Area (see above)
All Positives Possible	LaDonna Williams (Programs Director), Pat Dodson and Janniece Murray	https://www.guidestar.org/profile/61-1588146	East Bay nonprofit supporting efforts of low-income communities of color to confront crises of environmental health and injustice.
Bayview Hunters Point Resident	Dr. Raymond Tompkins	N/A	N/A
California Climate Health Now	Ashley McClure, Cynthia Carmichael	https://www.climatehealthnow.org/	California physicians and health professionals "who recognize climate change as the public health and equity emergency of our lifetimes."
Communities for a Better Environment	Andrés Soto	http://www.cbecal.org/	California environmental justice organization focused on global climate issues and local transformation toward sustainable communities. Provides organizing skills, leadership training, and scientific and legal assistance.
Groundwork Richmond	Jen Fong	http://www.groundworkrichmond.org/	Richmond environmental organization helping youth develop leadership potential through science, technology, engineering, arts, and math.
Higher Ground Neighborhood Development Corp.	Khariyyah Shabazz (Assistant Programmatic Director) and Reggie Archie	http://www.highergroundndc.com/	Oakland-based neighborhood development corporation focused on youth.
Interfaith Climate Action Network of Contra Costa County	Will McGarvey,	http://www.ican-cc.org/	Contra Costa County organization educating faith and non-faith communities about mitigating climate change and providing advocacy on their behalf to ensure oppressed community voices are heard by policymakers, industries, and other organizations.

New Voices Are Rising/Rose Foundation	Katherine Funes (Youth Engagement Co-Director) & 3 youth	https://rosefdn.org/new-voices	Oakland-based project seeking to increase civic participation within underrepresented communities, increase young people's commitment to environmental justice, and reduce air and water pollution in the SF Bay Area. Part of the Rose Foundation for Communities and the Environment.
No Coal in Oakland	Misao Brown	https://nocoalinoakland.info/	Oakland-based organization campaigning to stop the threat of coal being transported by rail into Oakland for export overseas.
No Coal in Richmond	Jaime Perez	https://ncir.weebly.com/	Richmond-based organization supporting phase-out of coal and pet coke operations to protect health.
Physicians for Social Responsibility	Robert Gould (President), Jeff Ritterman (Vice President of Board of Directors)	http://sfbaypsr.org/	Bay Area chapter of organization seeking to promote public policies that protect human health from climate change and environmental degradation as well as nuclear war and other weapons of mass destruction, gun violence, and other social injustices.
Rodeo Citizens Association	Janet Pygeorge, Charles Davidsen	https://rodeocitizensassociation.org/	Non-profit organization devoted to issues concerning the unincorporated community of Rodeo, California. Their primary purpose is to address local concerns to health, safety and the environment.
Sierra Club Bay Chapter	Dave McCoard (Co-Chair of Energy Committee)	https://www.sierraclub.org/san-francisco-bay	SF Bay Area chapter of national grassroots environmental organization. Chapter has nearly 40,000 members. Issues include energy and climate, sustainable communities, parks and open space, environmental justice, water, and wilderness and wildlife.
Sunflower Alliance	Steve Nadel and Shoshana Wechsler	https://www.sunflower-alliance.org/	Bay Area citizen group focused on halting fossil fuel production and transport, particularly in the East Bay.
Vallejo Citizen Air Monitoring Network	Ken Szutu (Chair)	http://citizenairmonitoringnetwork.org/vallejo/	Vallejo citizen group collecting and publicizing local air quality data to enable rapid response to air quality problems.
Youth vs Apocalypse	2 youth	http://youthvsapocalypse.org/	Bay Area group of diverse young climate justice activists (ages 10-18) working to lift the voices of youth, in particular youth of color, and fight for a livable climate and an equitable, sustainable, and just world through policy advocacy. Supported by 350 Bay Area.

AGENDA: 4A

Community Reflections from Feb. 27 Community Summit on PM

Jed Holtzman, MEM
Senior Policy Analyst
350BayArea

on behalf of the

BAAQMD Network

To view a video recording of the following presentation please visit: http://baha.granicus.com/MediaPlayer.php?publish_id=86baaa39-9531-11ea-a2af-0050569183fa. This presentation starts 46 minutes and 30 seconds into the recording (0:46:30). It ends at one hour, 10 minutes, and 10 seconds (1:10:10).

C401

Intro/Context

The federal government is moving backwards on PM regulation.

California must lead the nation—and as usual, we here must lead the state—in reducing PM emissions to protect both public health and public coffers.

The current coronavirus pandemic highlights the necessity to prioritize steep PM reductions—particularly in frontline, overburdened, and disadvantaged communities, and those that have experienced environmental injustice and racism.

C402

Intro/Context

Communities' excess exposure to PM makes them significantly more vulnerable to the impacts of SARS-CoV-2 and the other health and environmental challenges that will be expected with ongoing climate warming.

We request that the Advisory Council make the strongest possible statement to the Board on the need for aggressive Air District action to reduce PM to the maximum extent feasible, in order to protect public health.

We need BAAQMD action on all cylinders, we need robust rulemaking, and we need it yesterday. Delay translates directly into death and suffering of Bay Area residents, at the rate of thousands per year.

Regional/Local

To even hope to meet a health-protective PM target, we need to attack it from both directions, using both regional AND local approaches.

Regional Approach

There is no safe level of PM exposure, the concentration-response curve is linear, and we could keep saving lives by further reducing PM emissions.

The Air District should set the lowest PM standard available to protect public health given the overwhelming data. If this requires coordinating with ARB and the legislature to take leadership, it won't be the first time.

Setting a truly health-protective PM standard in the Bay Area will provide the impetus for an effective PM Reduction Plan, with all feasible measures needed to achieve attainment of the standard.

C405

Local Approach

For locally significant sources of PM, staff is proposing to employ a toxic health risk approach.

Given the incredible failure with the implementation of Rule 11-18 on toxic risk reduction, how does the District think it is going to lean this approach to handle all needed PM reductions from local stationary and magnet sources as well?

And how will those reductions come at a relevant time scale, given thousands of deaths per year of delay?

C406

Local Approach

How can we identify problematic local sources and deal with them faster? We can't wait until all burdened communities get AB 617 designation, which is all the more unlikely now in the post-pandemic budgetary environment.

The status quo Air District process on toxics is not working and will not work on the timescale in which we need to see reductions.

So do you ramp up the HRA staff and workflow at the District by more than 10x? Or do you come up with an alternate regulatory strategy? Something must change.

Regional/Local

Whether locally or regionally, our common concerns are the strength and breadth of regulations and the speed and robustness of their implementation.

Paying to Pollute

Penalties for violations of Air District rules with any primary or secondary PM emissions impacts must be increased substantially to reflect the true costs to the Air District and public health.

Both greater penalties for violations and an augmented enforcement regime at facilities are needed to incentivize compliance and provide serious disincentives for multi-billion dollar companies to pollute.

In-plant or in-community reductions of PM should be required instead of allowing trading in PM credits, and a very large (e.g., 20-to-1) offset rate could be employed for out-of-community offsets to ensure reductions stay local.

Permitting

Currently, AD staff is looking at reforming your permit program to take into account cumulative impact of emissions sources, rather than looking at each new permit as taking place on a clean slate.

We need to see other reforms in the permitting system at the Air District—for example:

- To close loopholes—for example, the piecemealing of larger projects into small components to remain under legal and regulatory thresholds and minimize the appearance of project impacts.
- To change calculation methodologies that have resulted in over-permitting facilities (e.g., the 6th refinery problem).

Cost-Benefit Analyses

Air District cost-benefit analyses need to take into account a broader portfolio of monetized health damages beyond the limited subset currently employed.

AD staff is pursuing updating the PM health values used in these analyses, which will make the comparison between costs to a facility and costs to public health less imbalanced and more accurate. We support this critical work, which the state should have moved on many years ago.

This does not replace the need to include the many health benefits/averted health costs that a regulation could achieve when engaging in socioeconomic analyses.

Authority & Measurement

There are so many places where the Air District doesn't have authority and can't ensure emissions will come down as needed to protect—so where you do have authority, you need to take maximal action.

PM counters that at least provide ballpark figures would be superior to subjective opacity determinations.

Conclusions

PM pollution is every bit as injurious and deadly as it was when you met in October and December, but now we are all moving forward trying to address this difficult challenge in a more trying environment.

In this environment, it is even more important than ever to identify and prioritize major sources of PM with a rapid timeline of control.

The most important thing we have learned from this crisis can be summarized in the old Boy Scout motto: BE PREPARED. The Air District can help prepare us for the next health crisis by greatly reducing PM emissions and improving our baseline health and safety.

C413

Thanks!

jed@350bayarea.org

COVID WHILE BLACK

Context for the Following Presentation
By LaDonna Williams, All Positives Possible

COVID While Black is the lived experiences of Bayo Vista in Rodeo CA, and South Vallejo CA, two frontline African American severely disadvantaged communities located along the shores of the Carquinez Strait. They share a bridge, a strait, invisibility and environmental racism. In addition they suffer from some of the highest negative health rates in the region from living by polluting refineries, petroleum storage companies, huge tanker ships traveling through the Carquinez Strait (transporting millions of tons of gas & oil) releasing scores of toxins into the Carquinez waters and air, and a Wastewater Raw Sewage Treatment Plant located in their neighborhoods.

Further negative impacts from the devastating wildfires, nearby polluting industries, and now COVID-19 undoubtedly are causing heightened physical and mental health trauma, resulting in epic levels of negative health, financial, environmental and mental health crisis on these already overburdened communities. Their lived experiences dealing with unexplained skin lesions, and tumors, bloody noses, high rates of asthma, Bell's Palsy, premature hair loss, headaches, heart attacks, diabetes, high blood pressure, cancers and death, prematurely burying their families and friends remain largely ignored, invisible to agencies and elected officials. While the white communities like Tormey are personally escorted to safety by officials with their lived experiences being top priority, low-income African American communities like Bayo Vista and South Vallejo are left to shelter in place fending for themselves as agencies and elected officials continue to permit even more increases of toxic emissions into their neighborhoods, routinely telling these residents there's no threat to their health or environment.

As these communities brace for the next fiery explosions from nearby storage companies like NuStar Energy, or the toxic releases of white and black smoke emissions from the nearby Phillips 66 refinery causing further pollution in their air, while inhaling noxious odors from a close by Wastewater Raw Sewage Treatment Plant, located directly across the street from residents living in low income and/or public housing, and huge tanker ship's toxic spills releases causing more pollution. **Residents continue to plead for help demanding justice from agencies and elected officials with deaf ears who continue to rubber stamp, approve and permit millions of tons of toxic increases of emissions from countless polluters into severely disadvantaged neighborhoods.**

The impacts and suffering of severely disadvantaged communities must be treated as a state of emergency! Anything less is supporting environmental and systemic racism, against the most vulnerable populations with the least financial or legal support. **Contra Costa County Supervisors continue to rubber stamp expansions of the Phillips 66 refinery, permitting additional millions of tons/gallons of gas and oil and other toxic emissions into the air we breathe.** Across the bridge, Solano County Supervisors supported an out-of-country toxic cement plant from Ireland that would have been located in South Vallejo, less than a quarter mile from low-income housing, schools, and places of worship. We thank GOD for the community's strength and commitment to stop the Orcem cement plant from coming into the community. The elected officials, agencies, and church leaders who continue to permit and support expansions and increases of toxic emissions in severely disadvantaged neighborhoods, while claiming there is no significant risk associated with their approval of these operational expansions must be held accountable for the environmental injustices, deaths and racism in disadvantaged communities.

C415


AGENDA: 4B
COVID WHILE BLACK
COSCO SHIPPING
To view a video recording of the following presentation, please visit: http://baha.granicus.com/MediaPlayer.php?publish_id=86baaa39-9531-11ea-a2af-0050569183fa. This presentation starts one hour, 18 minutes, and 33 seconds into the recording (1:18:33). It ends at one hour, 48 minutes, and 34 seconds (1:48:34).
LaDonna Williams
All Positives Possible
www.allpositivesp.org
C416

Bay O Vista
Rodeo, CA
10/15/19

C417

Low Income
Bay O Vista
Housing Units
Rodeo, CA
10/15/19


RODEO, CA
10/15/19


SOUTH VALLEJO CARQUINEZ BRIDGE 10/27/19

SOUTH VALLEJO CARQUINEZ BRIDGE HWY 80 10/27/19

Bay Area Air Quality Management District

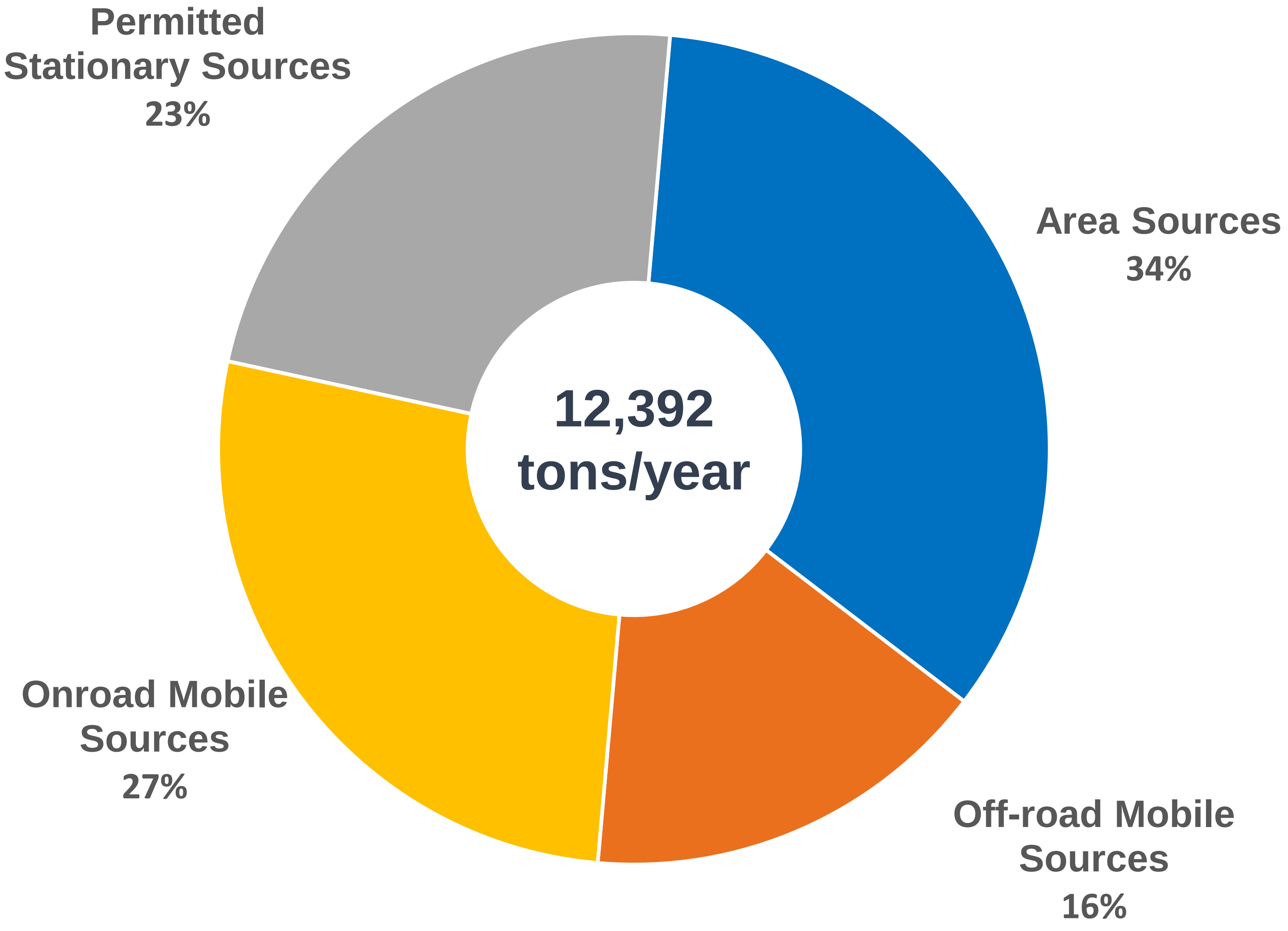
AGENDA: 5

Update on Air District Particulate Matter (PM) Potential Policy Strategies

Advisory Council Meeting
May 12, 2020

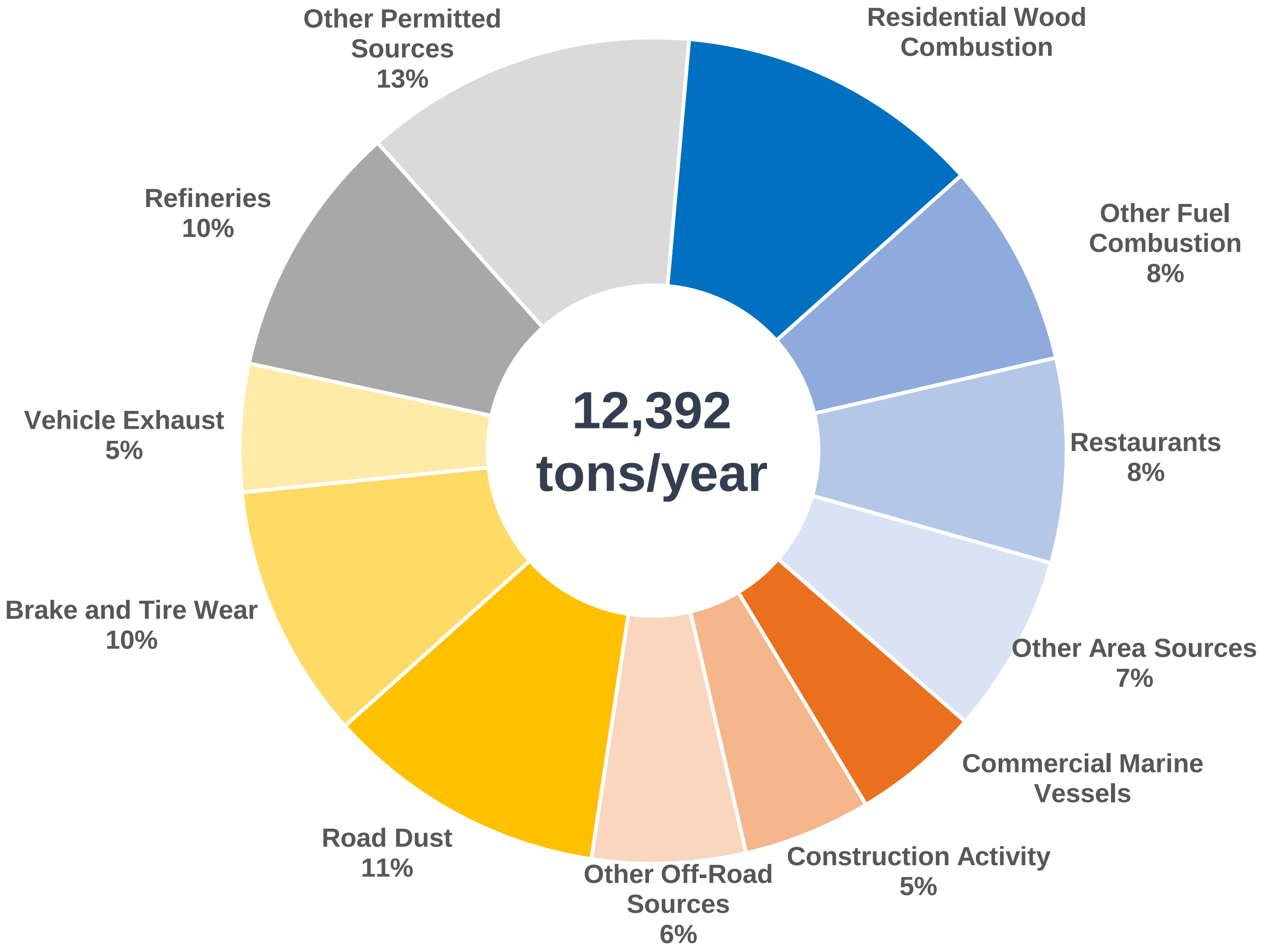
Greg Nudd
Deputy Air Pollution Control Officer

Major Sources of $PM_{2.5}$ in the Bay Area



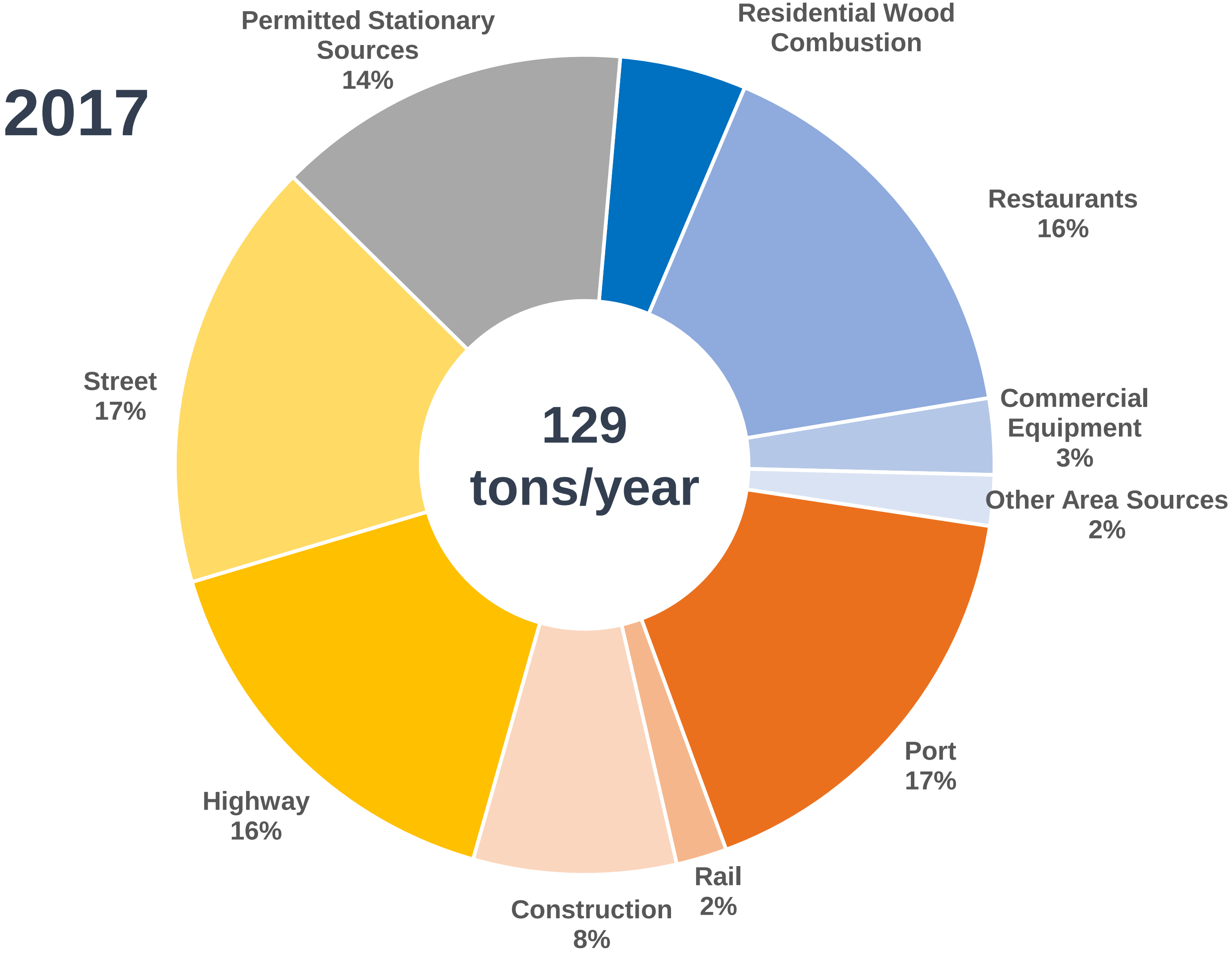
2016 annual average, directly emitted $PM_{2.5}$ emissions

Major Sources of $PM_{2.5}$ in the Bay Area



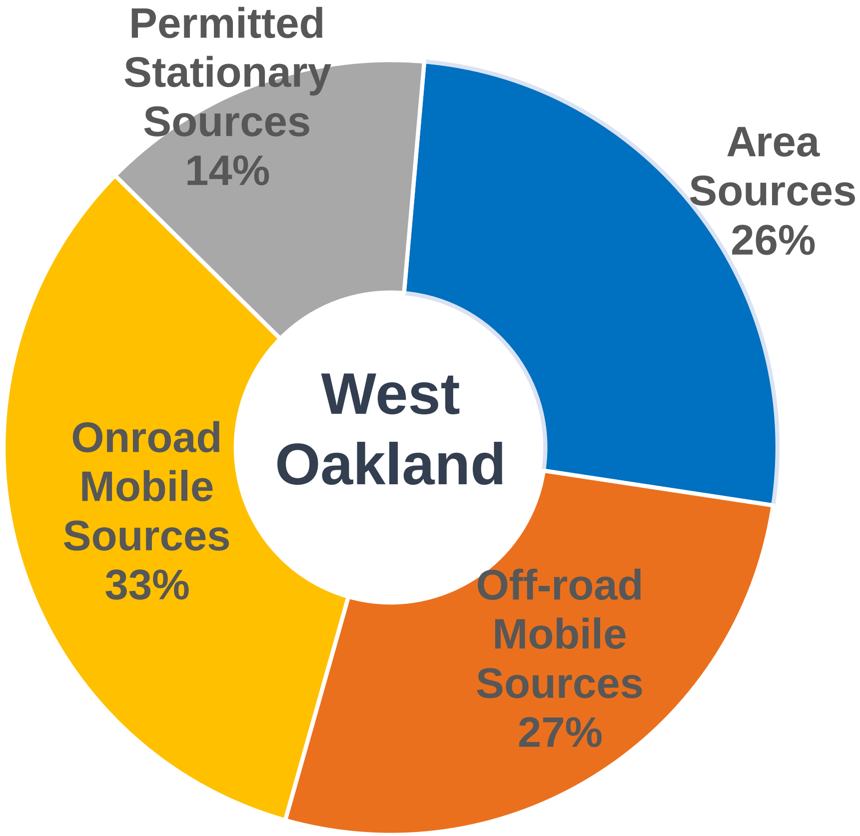
2016 annual average, directly emitted $PM_{2.5}$ emissions

Major Sources of $PM_{2.5}$ in West Oakland

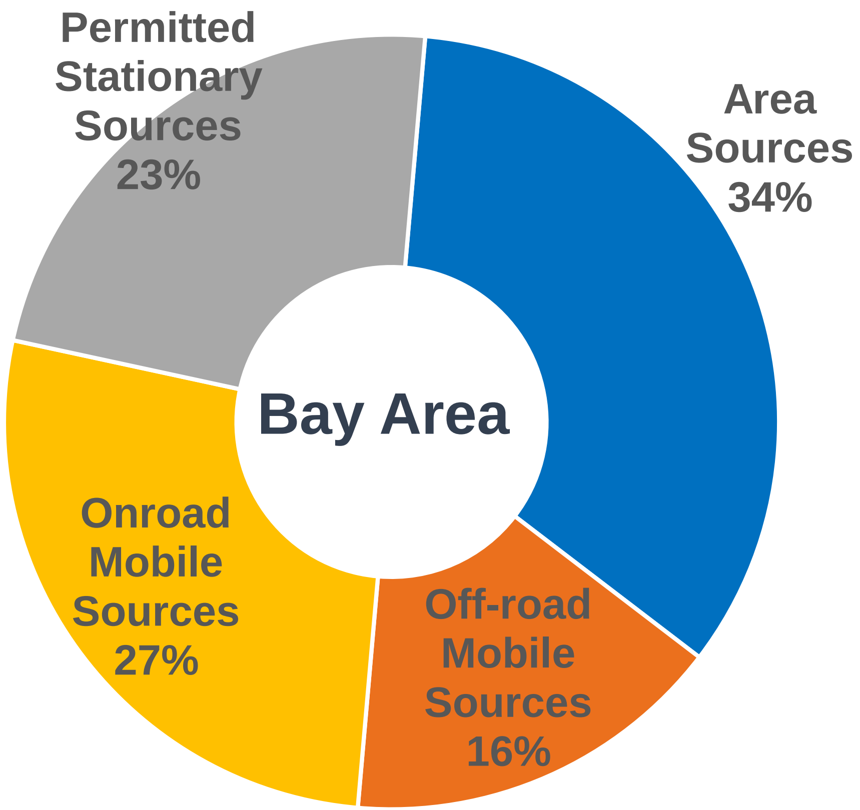


2017 annual average, directly emitted $PM_{2.5}$ emissions

$PM_{2.5}$ in West Oakland vs Bay Area



2017



2016

Current and Potential Actions

Mobile Sources	Permitted Stationary Sources
Area Sources	Magnet Sources

Current and Potential Actions

**On Road
Mobile Sources**

**Regulatory Authority:
California Air
Resources Board
(CARB)**

- **Existing programs:**
  - Diesel Free by ‘33
  - Spare the Air
  - Incentives for trip reduction (shuttles, bicycles)
  - Vehicle Buy-backs
  - Commuter benefits rule
  - Air District Incentives Programs
- **Potential new programs:**
  - Encourage telework
  - Assist local programs to control road dust

Current and Potential Actions (cont.)

Off Road Mobile Sources

Regulatory Authority: CARB

- **Existing Programs:**
  - Diesel Free by ‘33
  - Robust incentive programs for ships, trains, construction equipment
- **Potential New Programs:**
  - Push for stricter rules from CARB
  - Seek federal funding for electrification infrastructure

Current and Potential Actions (cont.)

Area Sources

**Regulatory Authority:
Air District**

- **Existing Programs:**
  - Restrictions on wood burning devices
  - Winter Spare the Air Program
  - Rule limiting charbroiler emissions
- **Potential New Programs:**
  - Require disabling of wood burning devices upon sale
  - Use regulatory authority to encourage electric space and water heating
  - Incentives for restaurant emission controls

Current and Potential Actions (cont.)

Permitted Stationary Sources

Regulatory Authority: Air District

- **Existing Programs:**
  - Multiple current regulations to reduce PM from refineries, metal foundries, coke calcining, materials handling
  - New requirements under development to limit condensable PM from refineries and the cement kiln
  - Permitting rules cap PM and precursors region-wide
- **Potential New Programs:**
  - New rule to limit site-wide health risk from PM
  - Modify permitting regulations to address localized health risks

Current and Potential Actions (cont.)

Magnet Sources

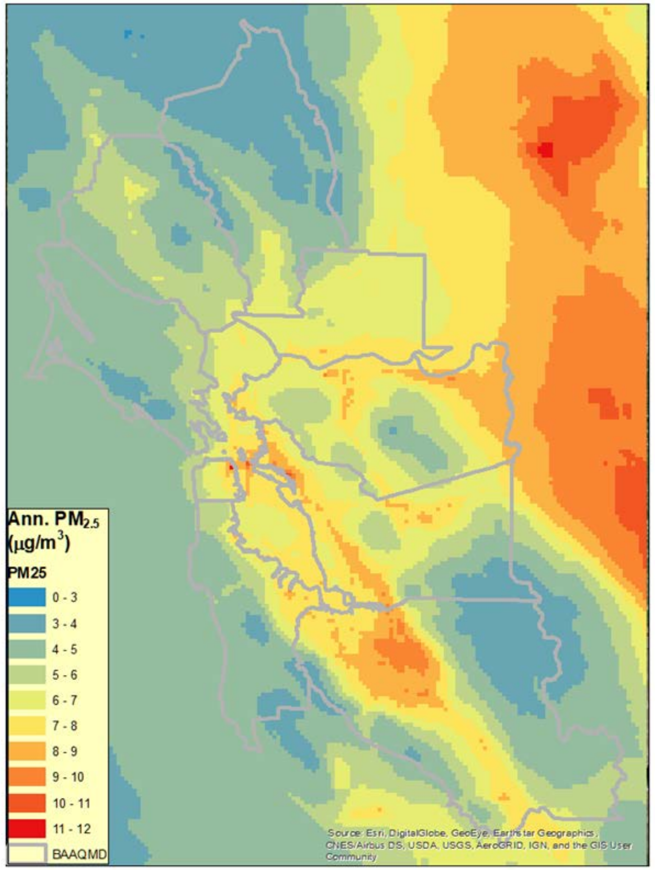
Regulatory Authority:
?

- **Magnet Source Rule(s)**

  Businesses that attract mobile sources: Examples: US Post Office facilities, port warehouses, and distribution centers

  Rule Development status: seeking changes to Air District authority at the state level

Gaps in Authority to Regulate PM



- Fine PM as Toxic Pollutant
- Establish Air Quality Standards for PM
- Magnet Sources of all forms of PM

Reducing Health Impacts of Fine PM

Air District Next Steps

- **Considerations of health impacts**
  - Community-level health exposure assessments
  - Health-benefit analyses
- **Establish "Goals" for PM reductions**
- **Additional Rule Development Efforts**

Questions?

AGENDA: 4A

PRESENTATION TO BAAQMD ADVISORY COMMITTEE

Proposed Guiding Principles for Consideration in Forwarding Recommendations to the BAAQMD on PM2.5 Regulation

Frances Keeler, CCEEB

July 31, 2020

California Council for Environmental and Economic Balance

The California Council for Environmental and Economic Balance (CCEEB) is a nonpartisan, nonprofit coalition of labor, business, and public leaders that advances strategies for a healthy environment and sound economy. CCEEB represents many facilities that operate in the Bay Area Air Quality Management District.

Guiding Principles

Recommendations from the AC to the BAAQMD should:

- Be based on best peer-reviewed science
- Consider input/lessons learned from other agencies
- Consider $PM_{2.5}$ speciation and source apportionment
- Address regional vs local impacts and control strategies
- Include an economic evaluation
- Prioritize strategies by greatest amount of near-term, cost-effective reductions

C438

Scientifically Based Recommendations

Recommendations:

- Must be informed by the best, scientifically-based data possible
  - *Is more data needed and , if so, what is needed?*
- Should be based on peer-reviewed studies
- Should consider guidance developed by other agencies
- Data collection versus modeling
- Should demonstrate causal relationship before recommending controls
- Should be all inclusive

Coordination Between Agencies

- AC should consult other agencies on health standards
  - *CARB – sets SAAQS*
  - *OEHHA*
  - *CA Air Districts*
- AC Should direct Staff to work with other agencies
- AC should consider measures agencies are implementing to reduce PM and how it might advance the goals of the BAAQMD
  - *CARB is adopting many strategies for mobile sources that will reduce $PM_{2.5}$*
  - *BAAQMD has regulations in the plan and in process to further reduce $PM_{2.5}$*
  - *State is developing strategies to address wildfires*

C440

PM Speciation

- **Advisory Council must examine speciation**
- **There are many contributors to PM2.5**
  - *Mobile sources*
  - *Commercial sources (restaurants)*
  - *Residential sources (wood burning fireplaces, fire pits, BBQs)*
  - *Material handling*
  - *Industrial combustion sources*
  - *Secondary formation sources*
  - *Naturally occurring sources*
  - *Wildfires*
- **Speciation/source apportionment are key to determining the most effective means of reduction**
  - *Not about exoneration, but about effectiveness*

Regional vs Local Controls

- $PM_{2.5}$ levels vary at the localized level
  - *Different sources contribute to $PM_{2.5}$ levels in different communities*
- Are regional reductions more effective than localized reductions?
- What is the goal and how do we best achieve it?
- Have the COVID response measures changed impacts on either the regional or local level and is any of the change permanent?

Economic Impacts

- Need to focus limited resources where they will be most effective
- AC should review research that includes economic analysis of potential PM control strategies and identify/recommend proven strategies that can be implemented expeditiously and economically

C443

Prioritize Recommended Measures

- Identify the goal and recommend:
  - *Measures with greatest ground-level concentration reductions*
  - *Measure with greatest impact*
  - *Measures available near-term versus future reductions*
  - *Most cost-effective measures*
  - *Measures that reduce the most impactful portion of $PM_{2.5}$*

Factors Beyond the Scope of the Advisory Council

- District Authority
  - *State and Federal government establish standards/regulate mobile sources*
- CEQA analysis of control options
- Resources
- Cost-effectiveness threshold

C445

BAAQMD Action on Advisory Council Recommendations

- **Action informed by best, scientifically-based data possible**
  - *Will help determine what to regulate first and where/how to get the most effective reductions*
- **Consider input/peer review/actions from other agencies**
  - *What vetted methods are other agencies doing to reduce $PM_{2.5}$ emissions*
  - *How might those regulations benefit the Bay Area?*
- **Regional vs Local Control**
  - *Where should BAAQMD focus its attention first?*
- **Consider $PM_{2.5}$ speciation/source apportionment**
  - *Important to determining the most effective approach*
- **Include economic evaluation**
  - *How to obtain the greatest cost-effective reductions?*

GRADIENT

Assessing the Health Effects of Particulate Matter

Julie E. Goodman, Ph.D., DABT, FACE, ATS
Gradient

Bay Area Air Quality Management District

Advisory Council Meeting
July 31, 2020

Julie E. Goodman, PhD, DABT, FACE, ATS

- SB, Environmental Engineering, MIT, 1996
- ScM, Epidemiology, Johns Hopkins, 2000
- PhD, Toxicology, Johns Hopkins, 2002

- Cancer Prevention Fellow, National Cancer Institute, 2002-2004
- Principal, Gradient, 2004-Present
- Board of Health, Canton, MA, 2008-Present
- Adjunct Faculty, Harvard School of Public Health, 2009-2017

- Diplomate, American Board of Toxicology
- Fellow, American College of Epidemiology
- Fellow, Academy of Toxicological Sciences

Health Sciences

Epidemiology – The study of the distribution and determinants of health effects

Toxicology – The study of potential adverse health effects of substances on living organisms

GRADIENT

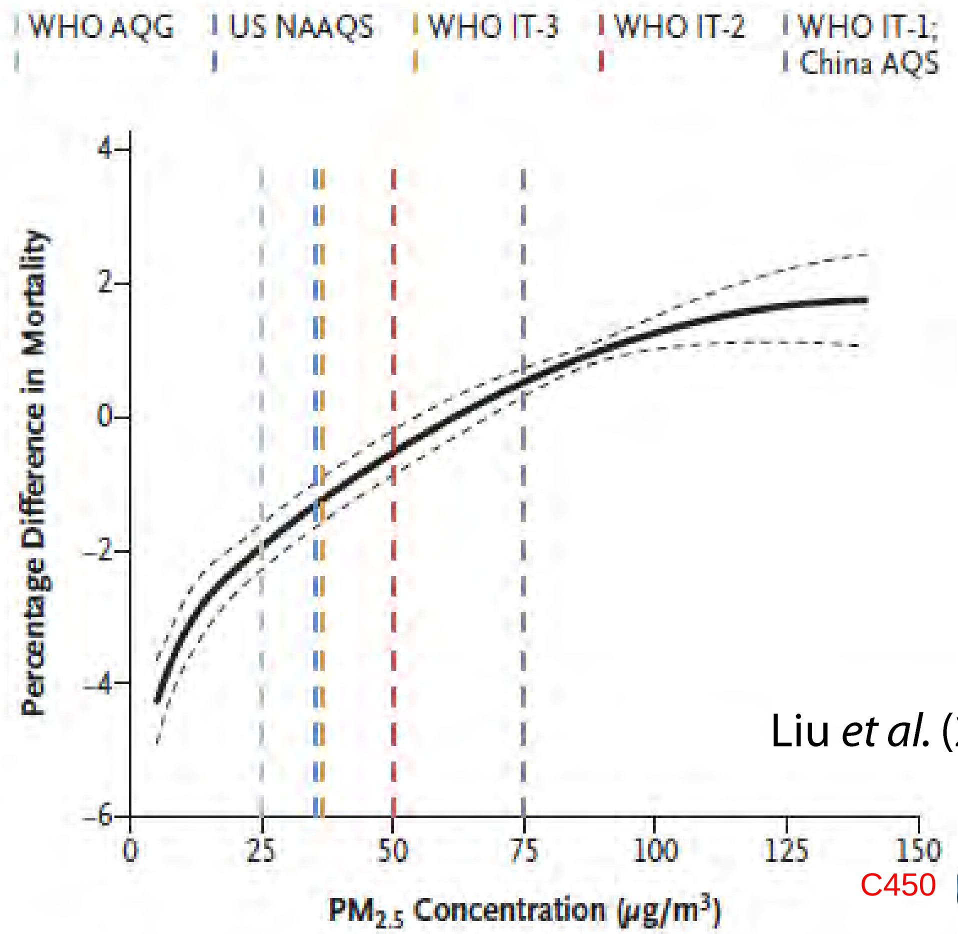
PM Associations vs. Causation

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 AUGUST 22, 2019 VOL. 381 NO. 8

- PM is associated with morbidity and mortality in many traditional epidemiology studies
- Associations, particularly at low concentrations, are small in magnitude
- Association does not always mean causation
- Most likely explanation
  - Bias (*e.g.*, exposure measurement error)
  - Confounding
  - Chance
  - Inappropriate statistical model

Ambient Particulate Air Pollution and Daily Mortality in 652 Cities



Liu *et al.* (2019)

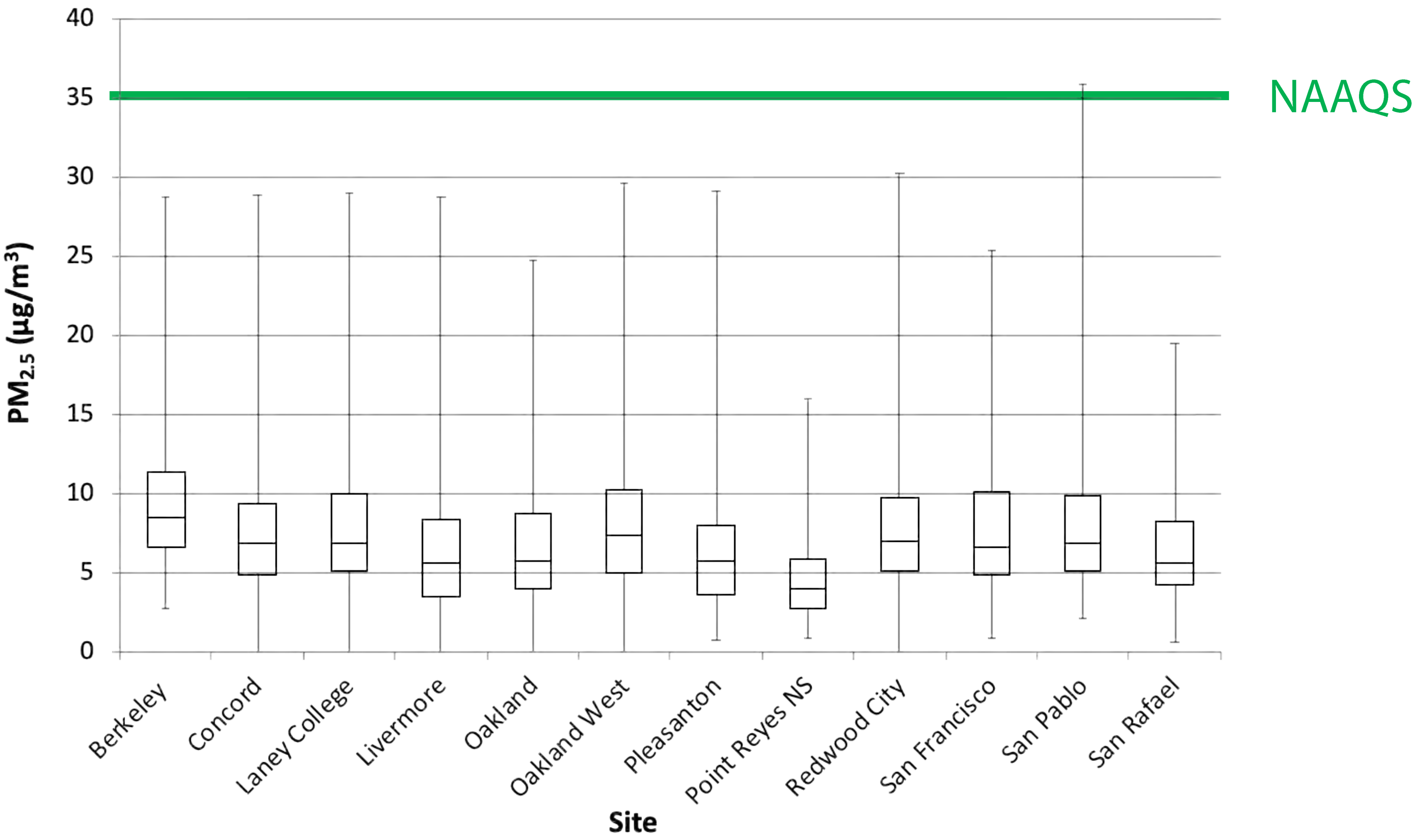
C450 GRADIENT

H. Christopher Frey June Air Quality Presentation, June 2020

- Need to consider population density, multiple pollutants, other factors
- Issues with the validity of using satellite retrieval without ground-based validation
- Larger cities have higher levels of air pollution and an increased opportunity for the spread of disease because there are many more people

There are similar issues with PM epidemiology in general

Daily Average $PM_{2.5}$ Concentrations in the Bay Area, 2019



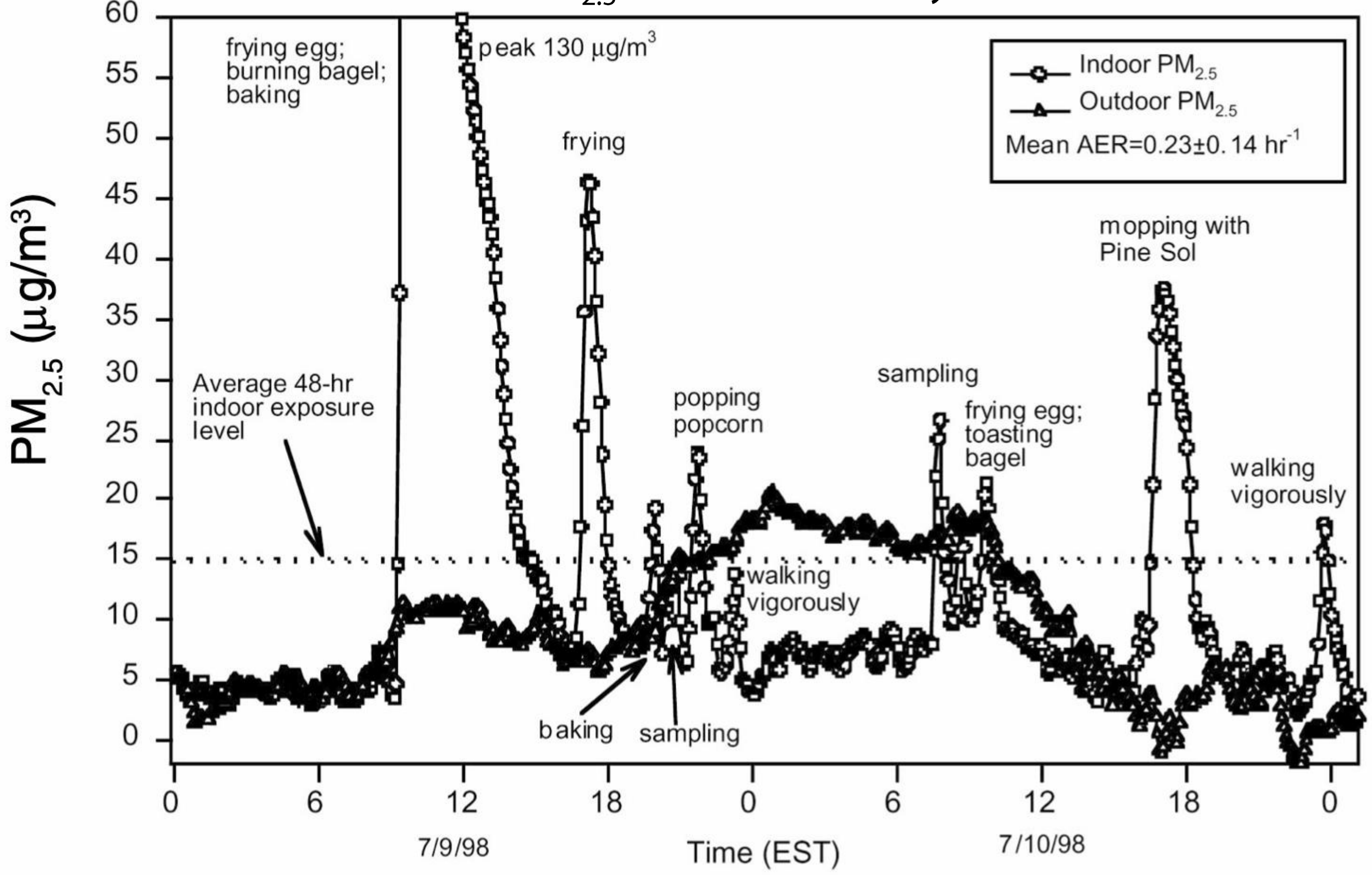
C452

Data from https://www.epa.gov/outdoor-air-quality-data

Exposure Measurement Error – Ambient Air Monitors

- Most studies use ambient air monitors
- People often spend a lot of time away from home
- People spend most time indoors
- Average PM exposures can be higher indoors

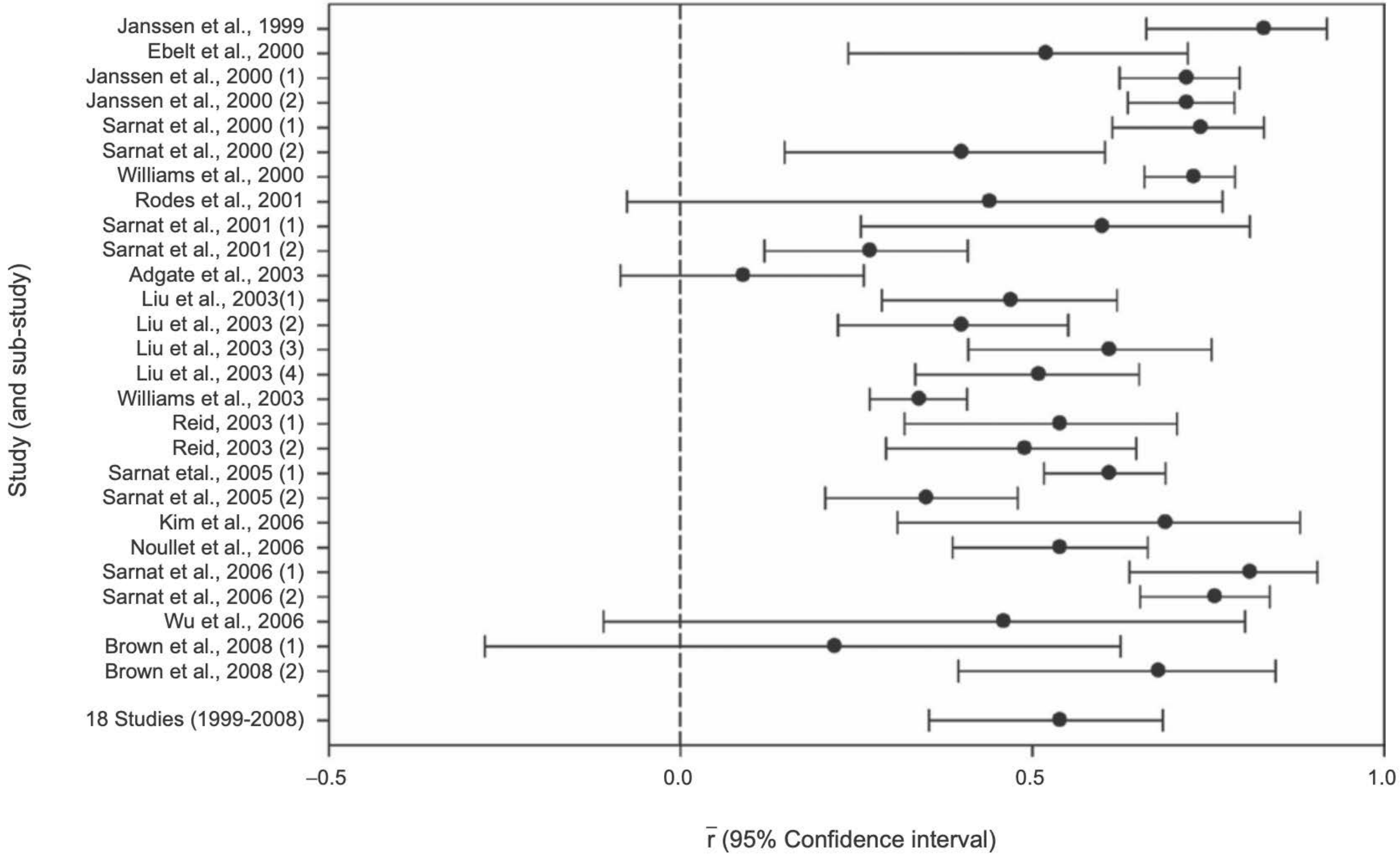
Indoor *vs.* Outdoor $PM_{2.5}$, Boston area, July 9-10, 1988



Long *et al.* (2000)
Harvard School of Public Health

C453

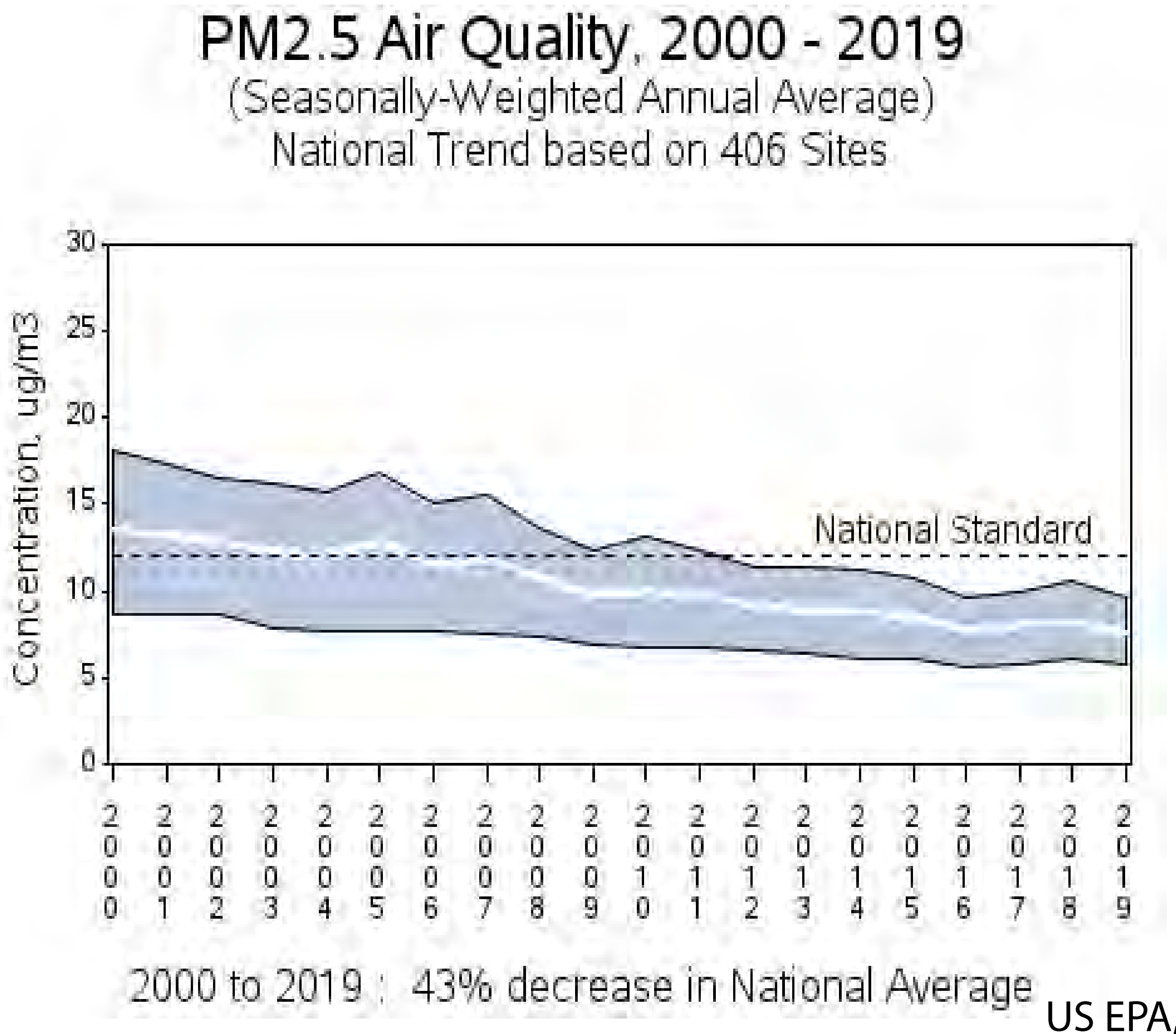
Exposure Measurement Error – Personal vs. Ambient $PM_{2.5}$ Associations Vary



Avery *et al.* (2011)

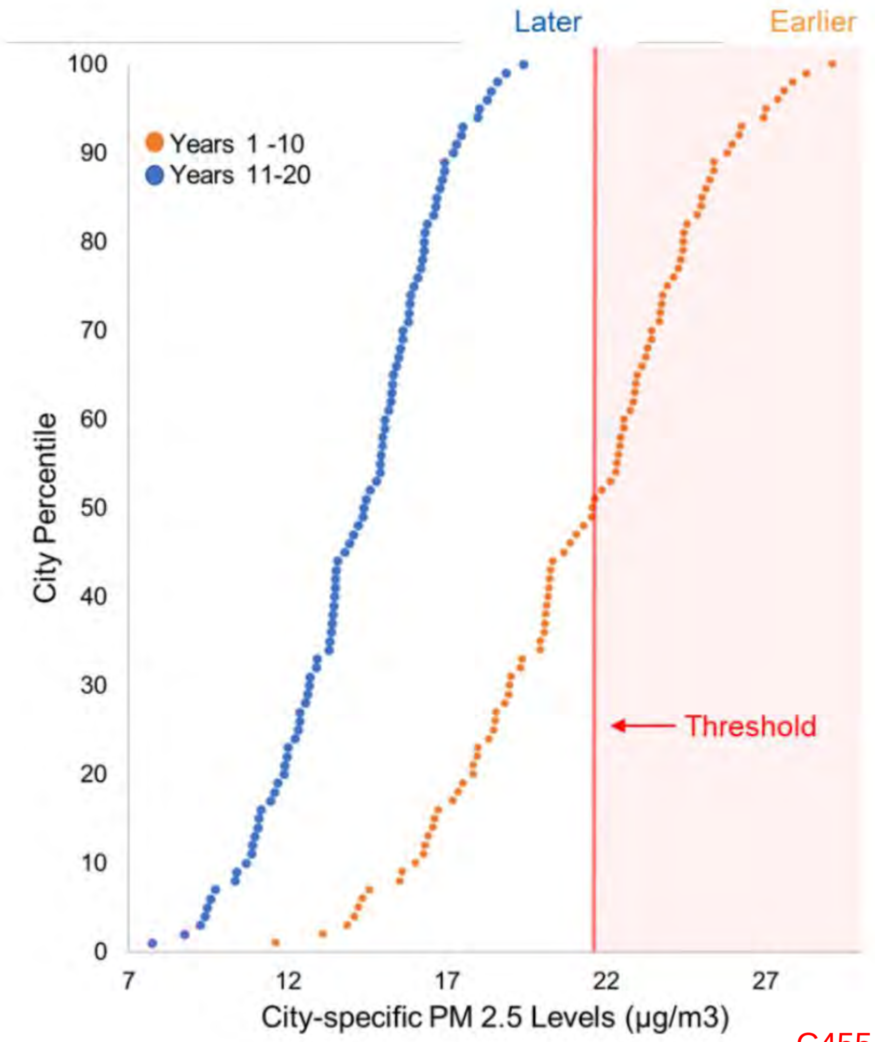
C454 GRADIENT

Exposure Measurement Error – Many Studies Evaluate the Wrong Exposure Window and Overestimate Associations



US EPA, 2020

Figure 1. PM2.5 Distributions in Illustrative Example

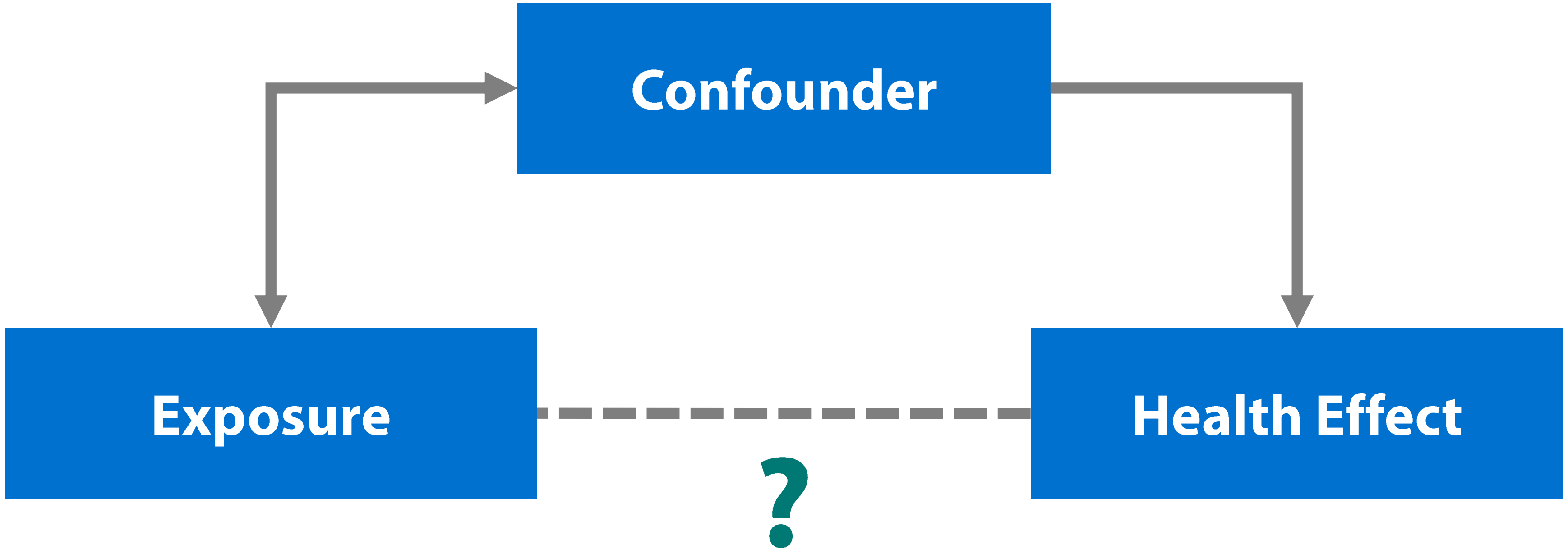


C455

Smith and Chang, 2020

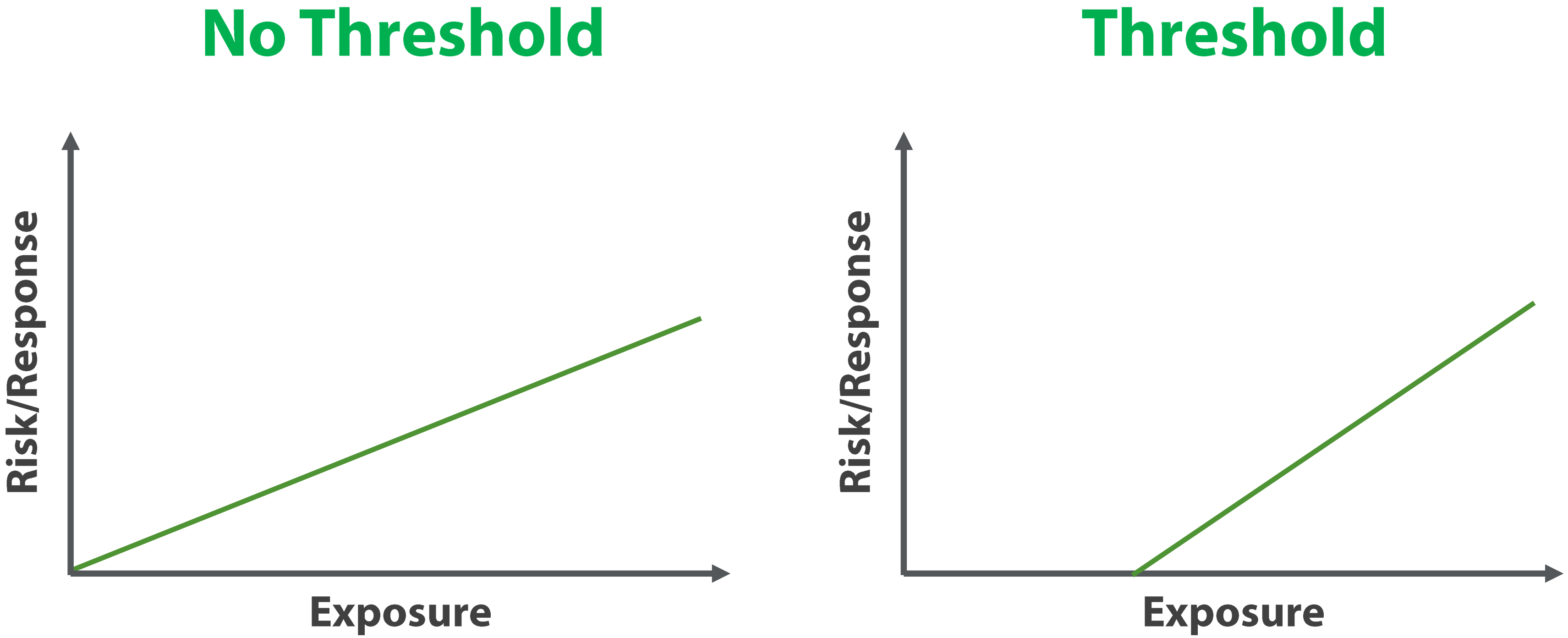
Confounding

- Other exposure window
- Atmospheric conditions
- Other copollutants, allergens
- Socioeconomic status (SES)
- Lifestyle factors (*e.g.*, smoking)
- Access to health care
- Genetics



GRADIENT

Model Choice and Measurement Error Linearizes Exposure-response Curve



GRADIENT

Measurement Error Linearizes Exposure-response Curve

REVIEW ARTICLE

Measurement error in environmental epidemiology and the shape of exposure-response curves

Lorenz R. Rhomberg, Juhi K. Chandalia, Christopher M. Long, and Julie E. Goodman

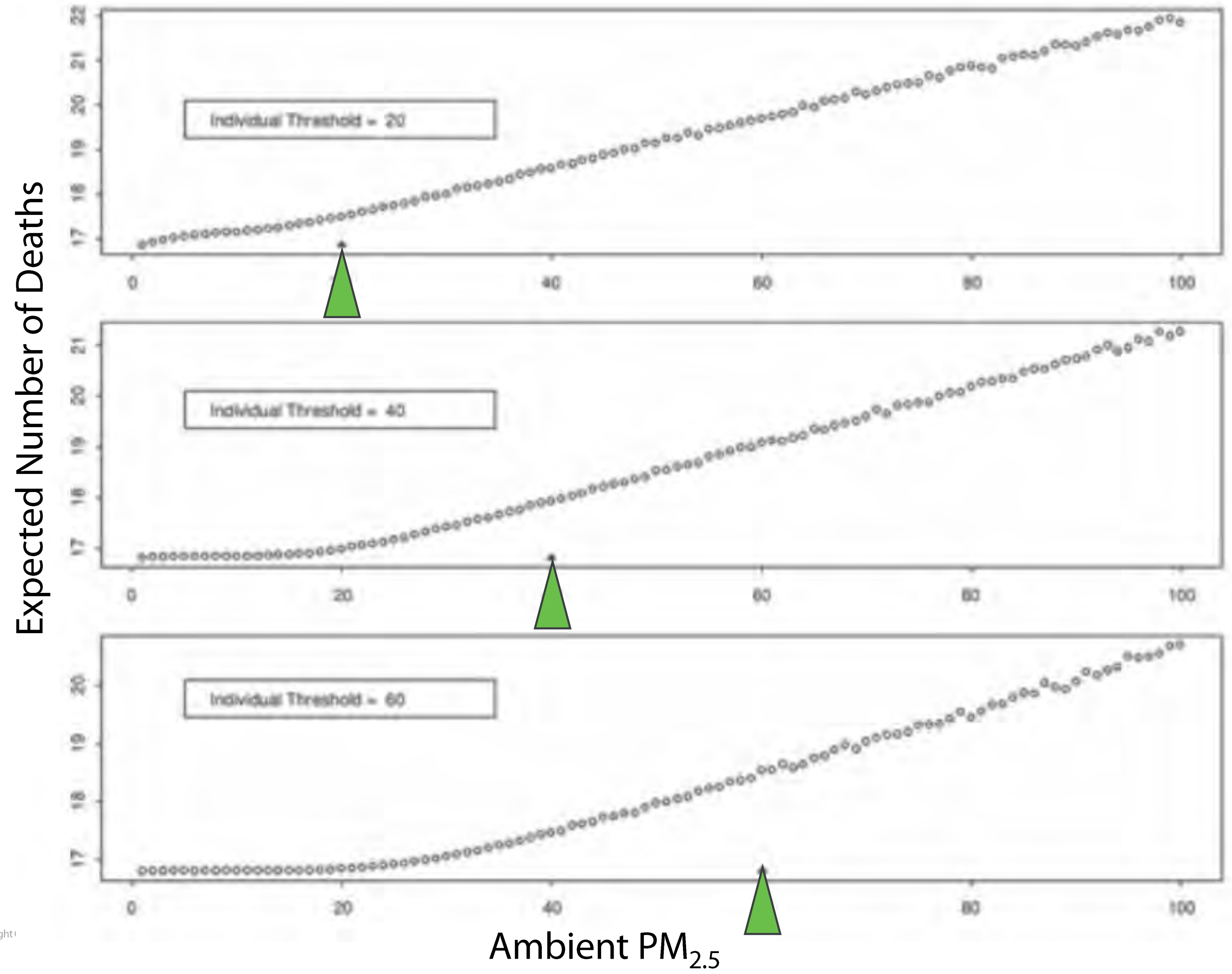
Gradient, Cambridge, Massachusetts, USA

Abstract
Both classical and Berkson exposure measurement errors as encountered in environmental epidemiology data can result in biases in fitted exposure-response relationships that are large enough to affect the interpretation and use of the apparent exposure-response shapes in risk assessment applications. A variety of sources of potential measurement error exist in the process of estimating individual exposures to environmental contaminants, and the authors review the evaluation in the literature of the magnitudes and patterns of exposure measurement errors that prevail in actual practice. It is well known among statisticians that random errors in the values of independent variables (such as exposure in exposure-response curves) may tend to bias regression results. For increasing curves, this effect tends to flatten and apparently linearize what is in truth a steeper and perhaps more curvilinear or even threshold-bearing relationship. The degree of bias is tied to the magnitude of the measurement error in the independent variables. It has been shown that the degree of bias known to apply to actual studies is sufficient to produce a false linear result, and that although nonparametric smoothing and other error-mitigating techniques may assist in identifying a threshold, they do not guarantee detection of a threshold. The consequences of this could be great, as it could lead to a misallocation of resources towards regulations that do not offer any benefit to public health.

Keywords: Epidemiology, exposure, exposure-response, measurement error, risk assessment

C458 GRADIENT

Exposure Misclassification Masks or Biases Thresholds



- True exposure was modeled.
- Corresponding risks calculated for simulated population using error based on observed exposure measurement error.

"True" threshold

Brauer *et al.* (2002)
University of British Columbia

C459 GRADIENT

Causal Methods Example – Burns *et al.* (2017)
Health Effects Institute Review of 42 Studies of 38 Interventions

Interventions

- Industrial
- Residential
- Vehicular
- Multiple

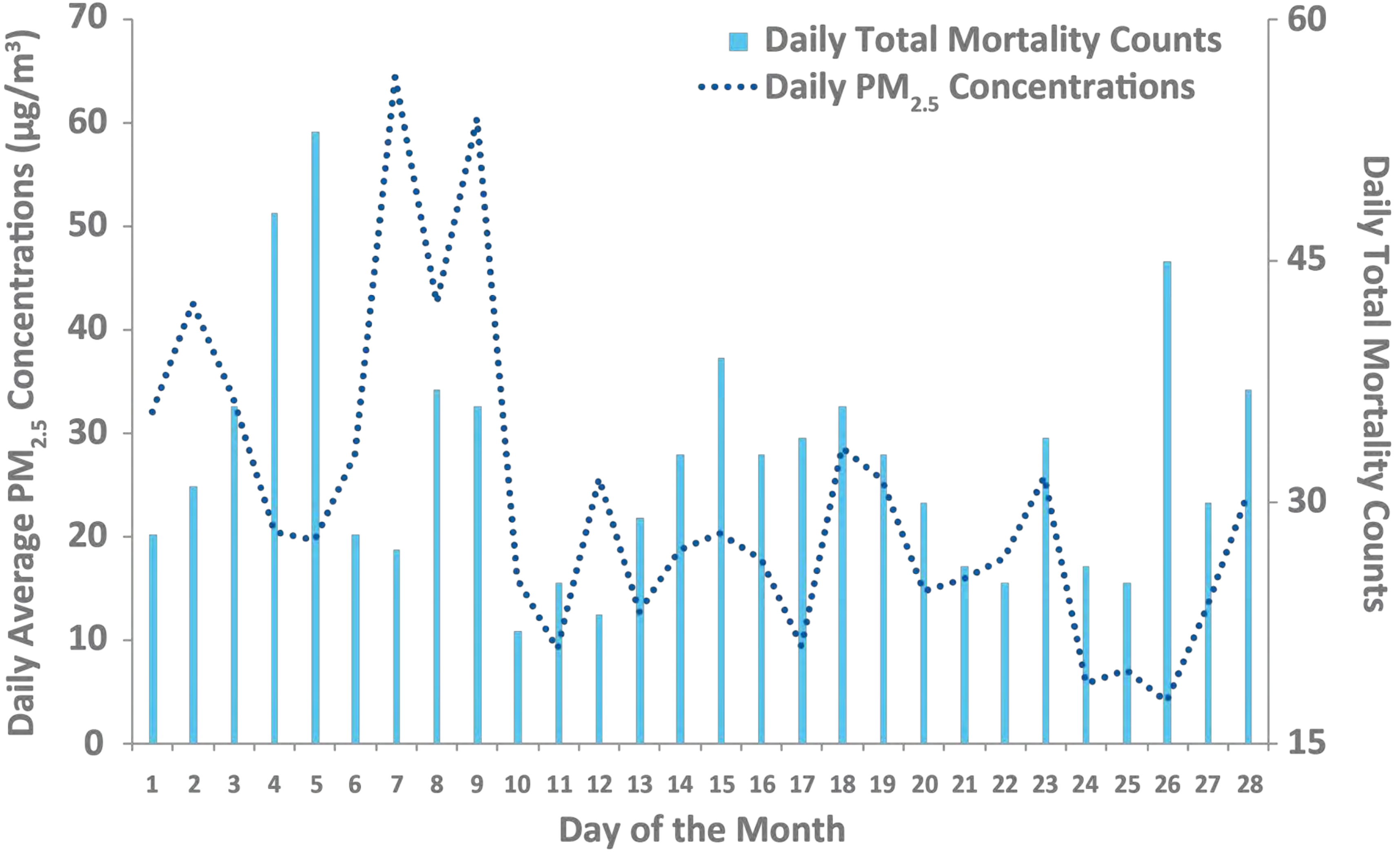
Comparison: *No restrictions*

Primary Outcomes

- All cause mortality
- Cardiovascular Mortality
- Respiratory Mortality
- PM_{10}
- $PM_{2.5}$
- Coarse PM
- Soot
- Black carbon (BC)
- Black smoke (BS)
- Elemental carbon (EC)

Results: "Evidence for effectiveness was mixed. Most included studies observed either no significant association or an association favoring the intervention, with little evidence that the assessed interventions might be harmful."

Example: $PM_{2.5}$ and Mortality in Greater Boston, 2002, after Quebec Forest Fires



Zu *et al.* (2016)

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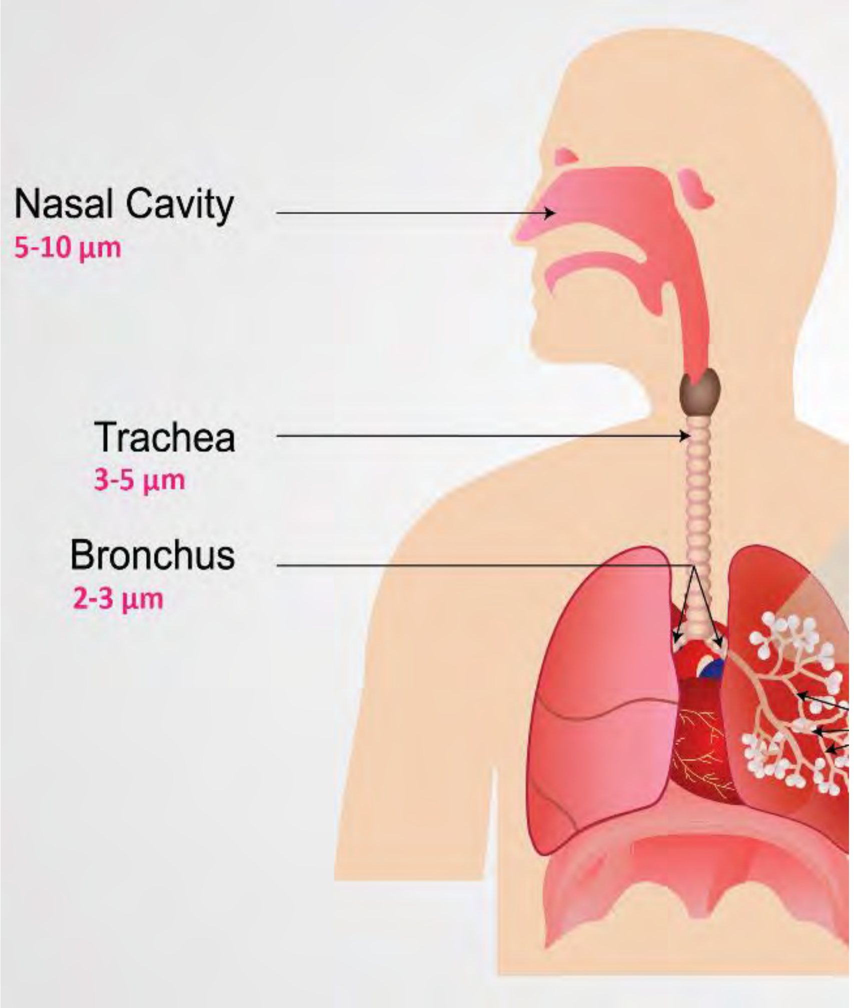
Toxicity Studies – There is a threshold below which people can be exposed to PM and not experience health impacts

- If exposures are sufficiently low, PM will not cause adverse health effects because it won't overwhelm the body's natural defenses.
- This is supported by experimental studies in humans and animals.
- CARB relies on this principle for all other non-carcinogenic agents.
- There is no justification for assuming one particle will impact health.



The Peer-review Process Is Not Perfect- Long-term PM and Mortality Example

Sources of Bias and Uncertainty		Crouse *et al .* (2012)	Crouse *et al .* (2015)	Villeneuve *et al.* (2015)	Chen *et al.* (2016)	Pinault *et al.* (2016)	Wong *et al.* (2015)	Beelen *et al.* (2014)	Cesaroni *et al.* (2013)	Lepeule *et al.* (2012)	Hart *et al.* (2015)	Shi *et al.* (2016)	Thurston *et al.* (2016)	Di *et al.* (2017a)
$PM_{2.5}$ Exposure Assessment	Central site monitoring (low spatial resolution)									X				
	No validation for $PM_{2.5}$ data						X						X	
	Temporal variation not accounted for	X	X	X	X			X	X					
	Residential mobility not accounted for	X		X		X	X	X		X		X		
	No evaluation on multiple exposure windows	X	X	X	X	X	X	X	X		X	X	X	X
	Personal activities not accounted for (*e.g.,* time spent indoors)	X	X	X	X	X	X	X	X	X	X	X	X	X
	Mismatch of $PM_{2.5}$ exposure window and mortality	X	X	X	X		X	X	X					X
Individual Covariates	No adjustment of individual covariates											X		
	Information bias (*e.g.,* self-reported covariates)	X	X	X		X	X	X		X	X		X	
	Temporal variation not accounted for	X	X	X	X	X	X	X	X	X			X	
	Unmeasured confounding (*e.g.,* pre-existing conditions)	X	X	X	X	X	X	X	X	X	X	X	X	X
Ecological Covariates	No adjustment of ecological covariates									X				
	Temporal variation not accounted for	X		X	X	X	X	X	X		X	X	X	
	Residential mobility not accounted for	X		X		X	X	X				X		
	Unmeasured confounding (*e.g.,* access to health care, violence)	X	X	X	X	X	X	X	X	X	X	X	X	X
Evaluation of Copollutants	No adjustment of copollutants	X		X	X	X	X			X	X	X		
	Central site monitoring (low spatial resolution)												X	
	No validation for copollutants data												X	
	Temporal variation not accounted for		X					X	X				X	
	Residential mobility not accounted for							X					X	
	Personal activities not accounted for (*e.g.,* time spent indoors)		X					X	X				X	X
	Collinearity/nonlinear relationship with $PM_{2.5}$ not addressed/accounted for												X	
	Mismatch of copollutants window and mortality		X					X	X				X	X
Statistical Analyses	Model assumptions not tested/relaxed		X	X		X	X	X	X		X	X	X	X
	C-R curves sensitive to *df* (natural splines)	X	X	X	X	NR	X	X	X				X	
	Nonlinearity not assessed statistically			X		X					X	X	X	X
	Threshold not assessed	X	X		X		X		X	X	X	X	X	X

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Conclusions – PM Threshold Is Likely Higher than Ambient Concentrations

- High concentrations of PM, and every other substance, can impact morbidity.
- There are clearly statistical associations between PM and morbidity and mortality in many epidemiology studies, even at lower, ambient concentrations.
- Evidence does not indicate associations are causal at ambient concentrations.
- There is a threshold below which people can be exposed to PM and not experience health impacts.

AGENDA: 5

Bay Area Particulate Matter (PM) Modeling-Based Assessments and Next Steps

Advisory Council Meeting
July 31, 2020

Phil Martien, PhD
Director of Assessment, Inventory, & Modeling Division

Overview

- PM modeling for the West Oakland Community Action Plan
  - Review community-scale assessment
- PM modeling of large industrial sources
  - Chevron Richmond Refinery
- Next Steps

Recent PM Assessments

- Identify source-contributions to impacts
  - What is responsible?
- Assess equity of impacts to inform decision-making
  - Support agency goal of reducing air pollution inequities
- Work toward highlighting health risks from fine PM ($PM_{2.5}$) exposures below federal standard
  - Develop a risk framework consistent with “no identified safe level of $PM_{2.5}$”

West Oakland Community Action Plan

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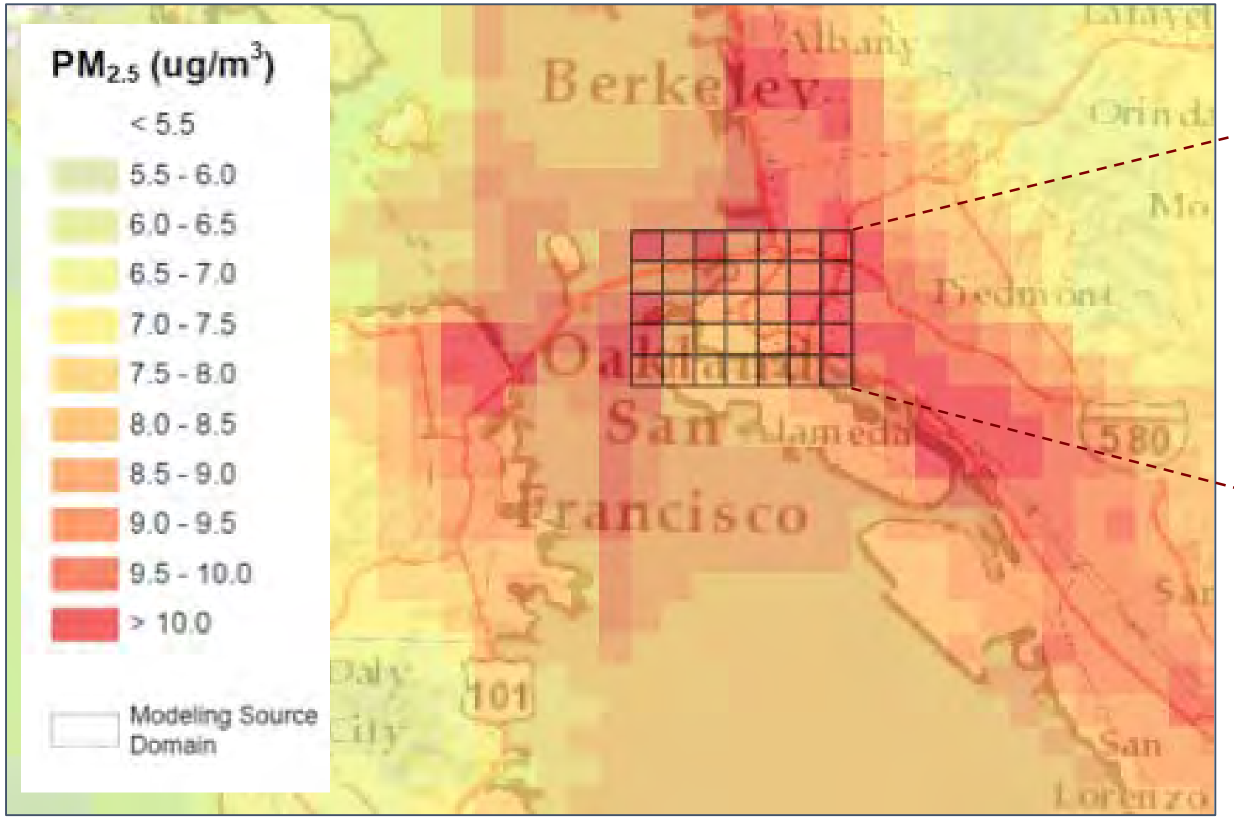
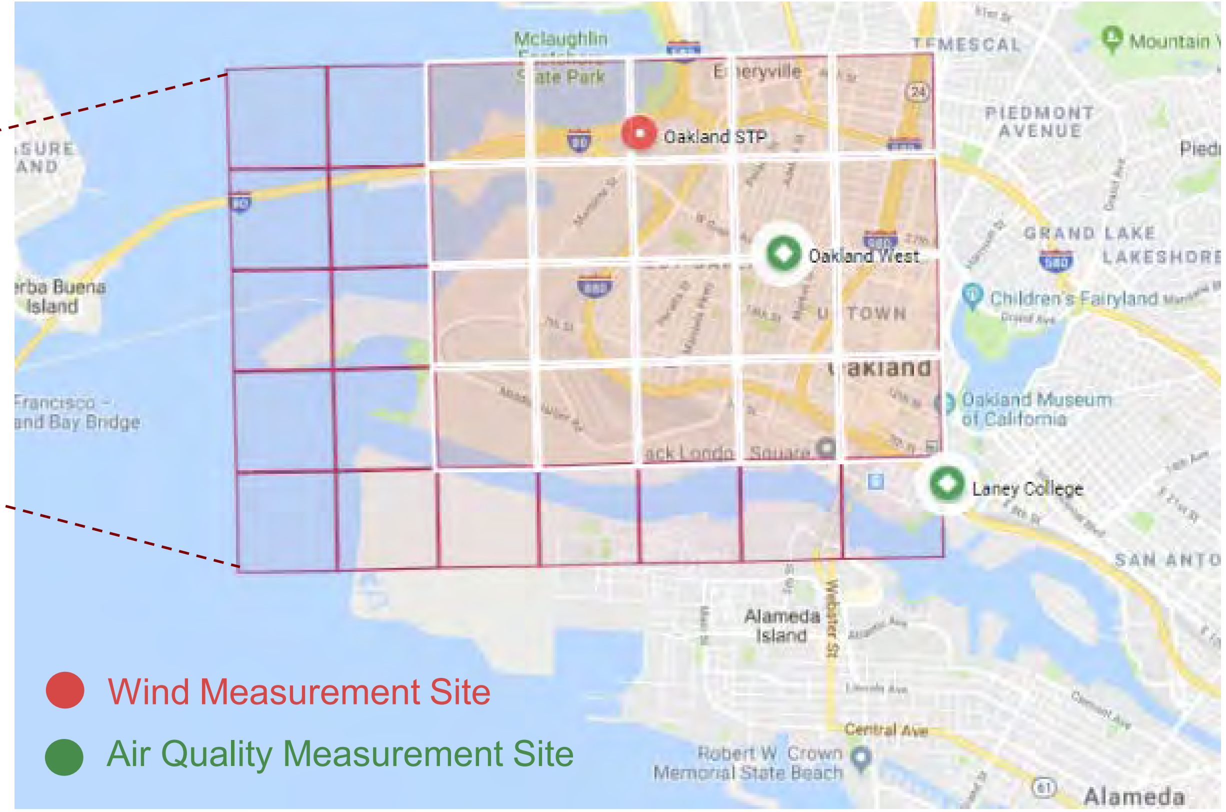
Regional-Scale and Community-Scale Modeling (2017)



Regional-scale modeling: covers the Bay Area



Local-scale modeling: covers West Oakland, including impacts in receptor area (white) from sources in source area (red)

Block by Block

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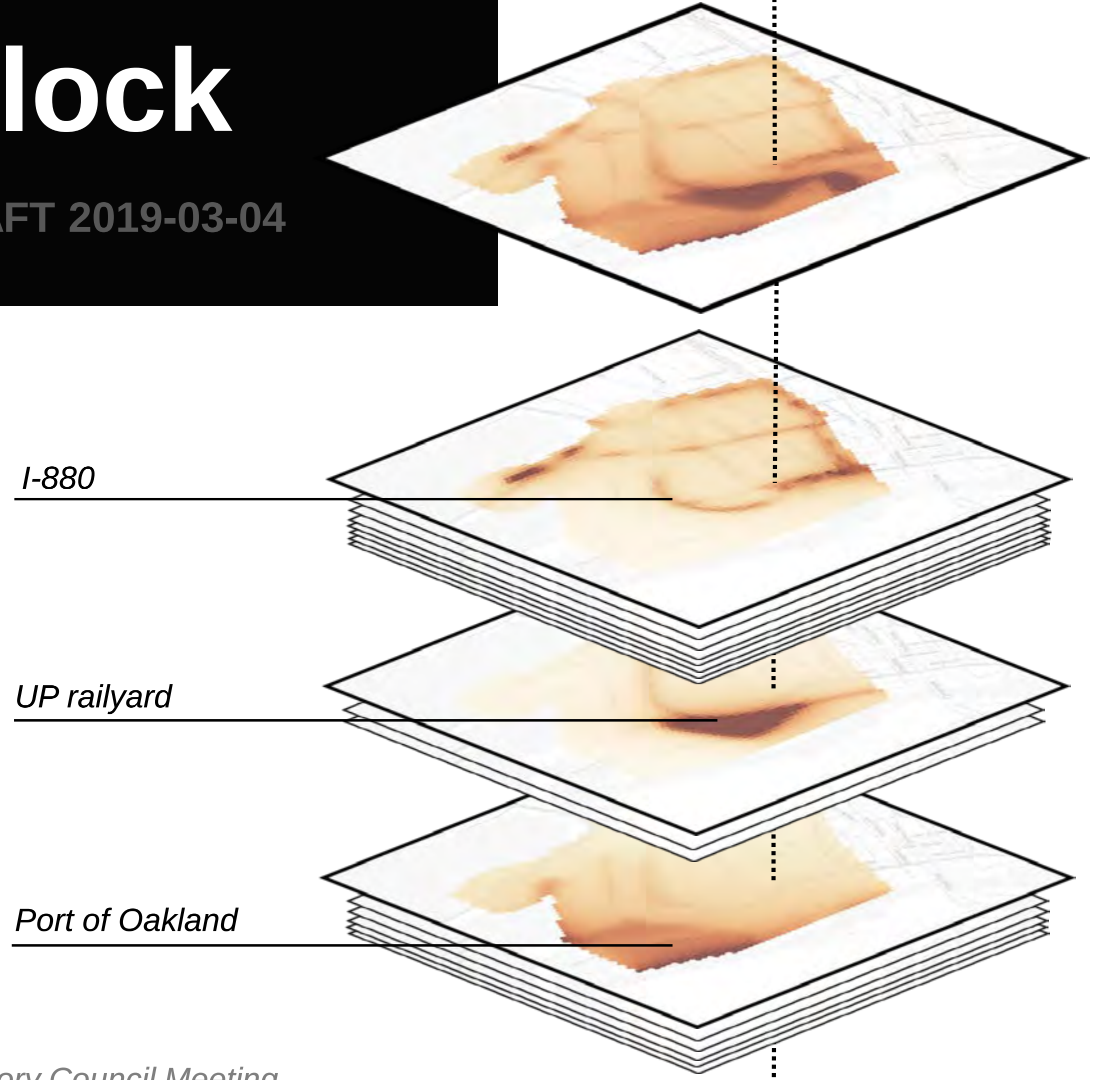
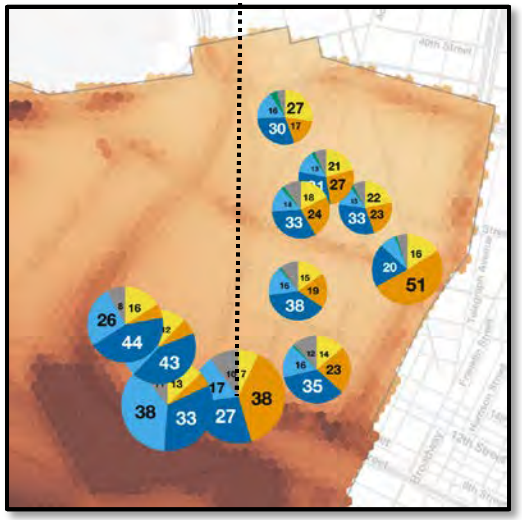


Grand total of modeled impacts from local sources

Sub-total from trucks, cars, and other vehicles on streets and highways

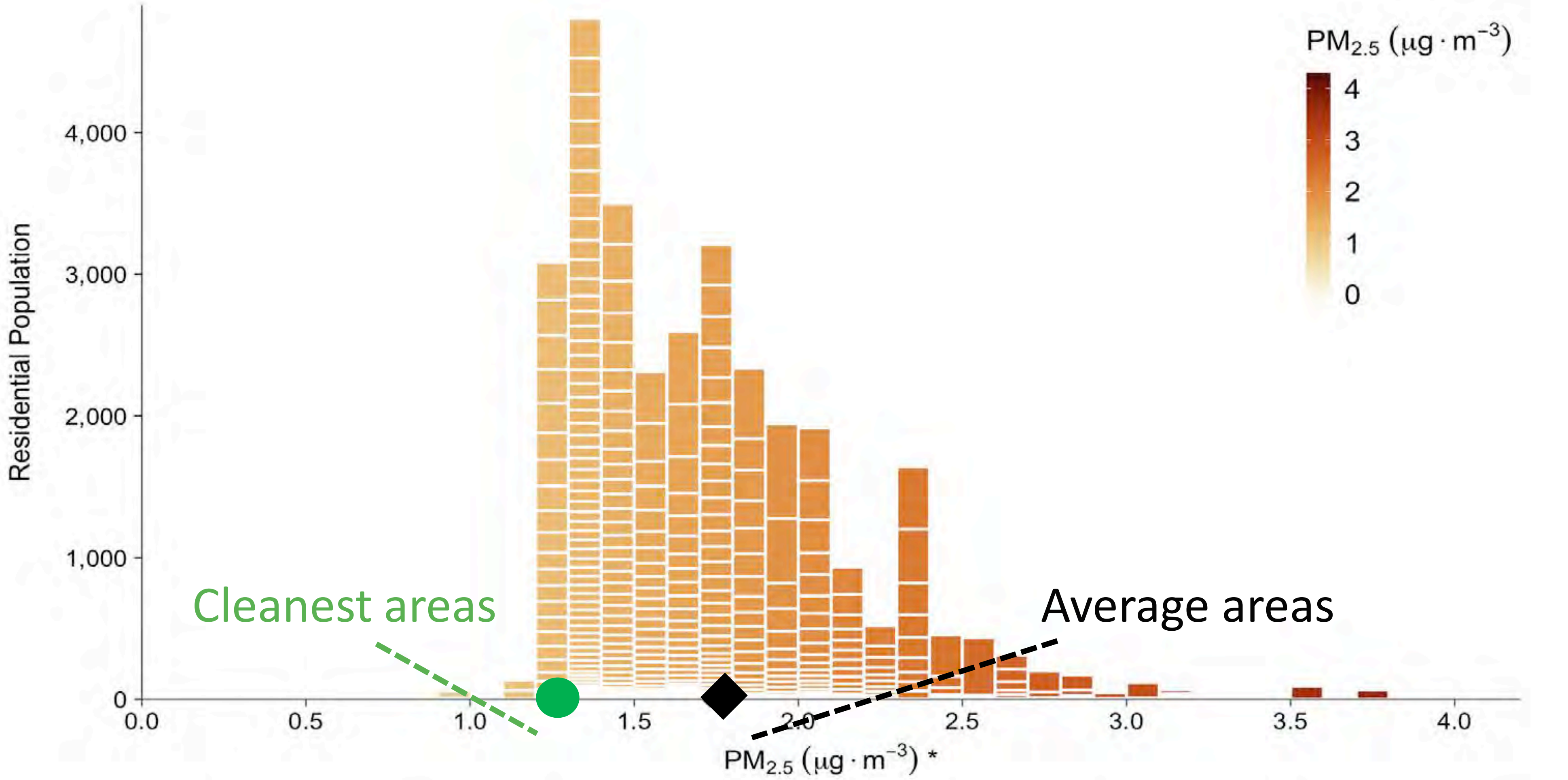
Sub-total from locomotive engines and railyards

Sub-total from harbor craft, ocean-going vessels, drayage, cargo handling, etc.



For any location, we can use the sub-totals to draw pie charts showing the relative impacts of sources A, B, C, etc.

Unequal Impacts: $PM_{2.5}$ Across West Oakland



* Contributed by modeled "present-day" emissions from existing local sources. Impacts from sources outside West Oakland not included.

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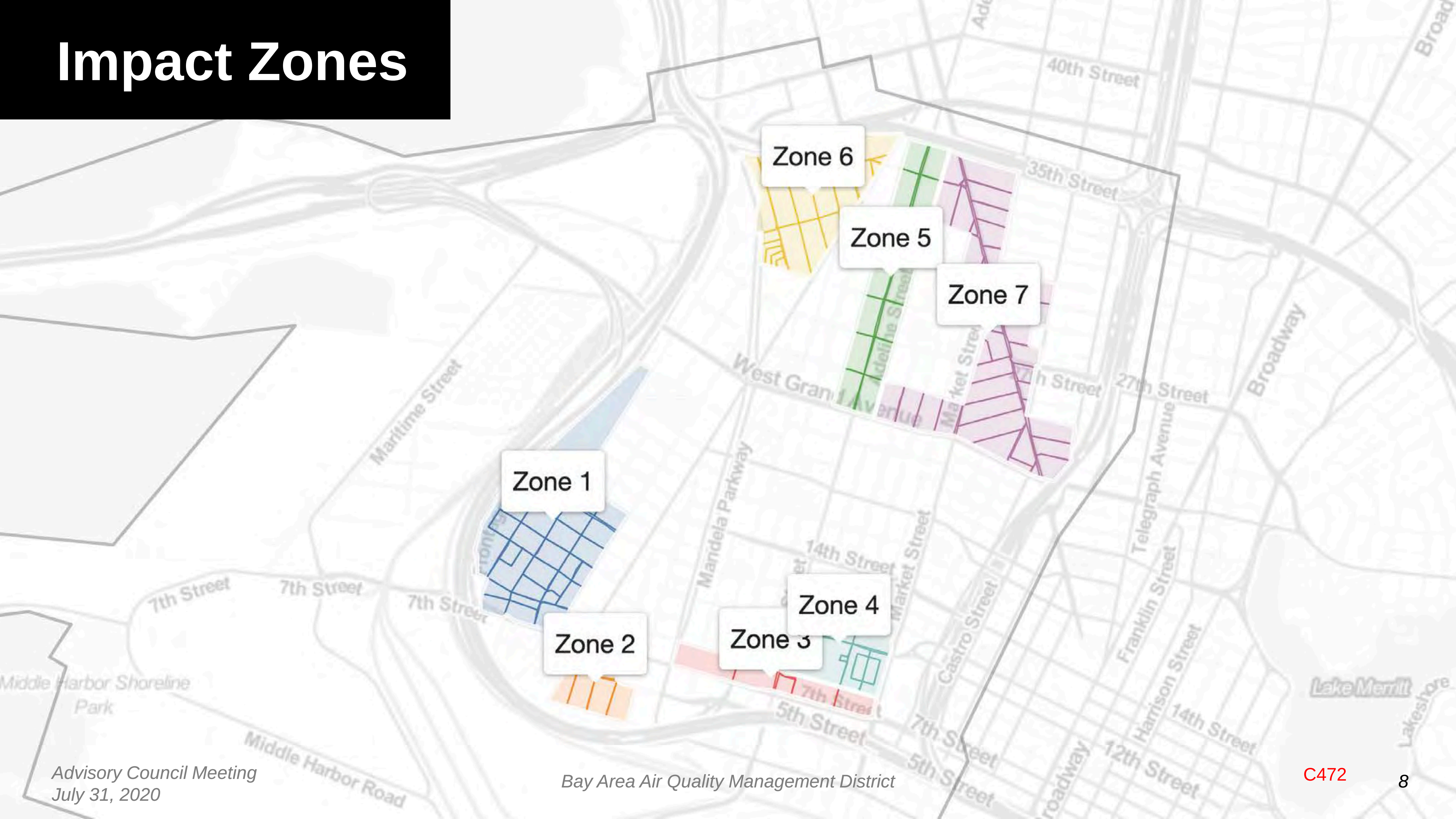
Impact Zones

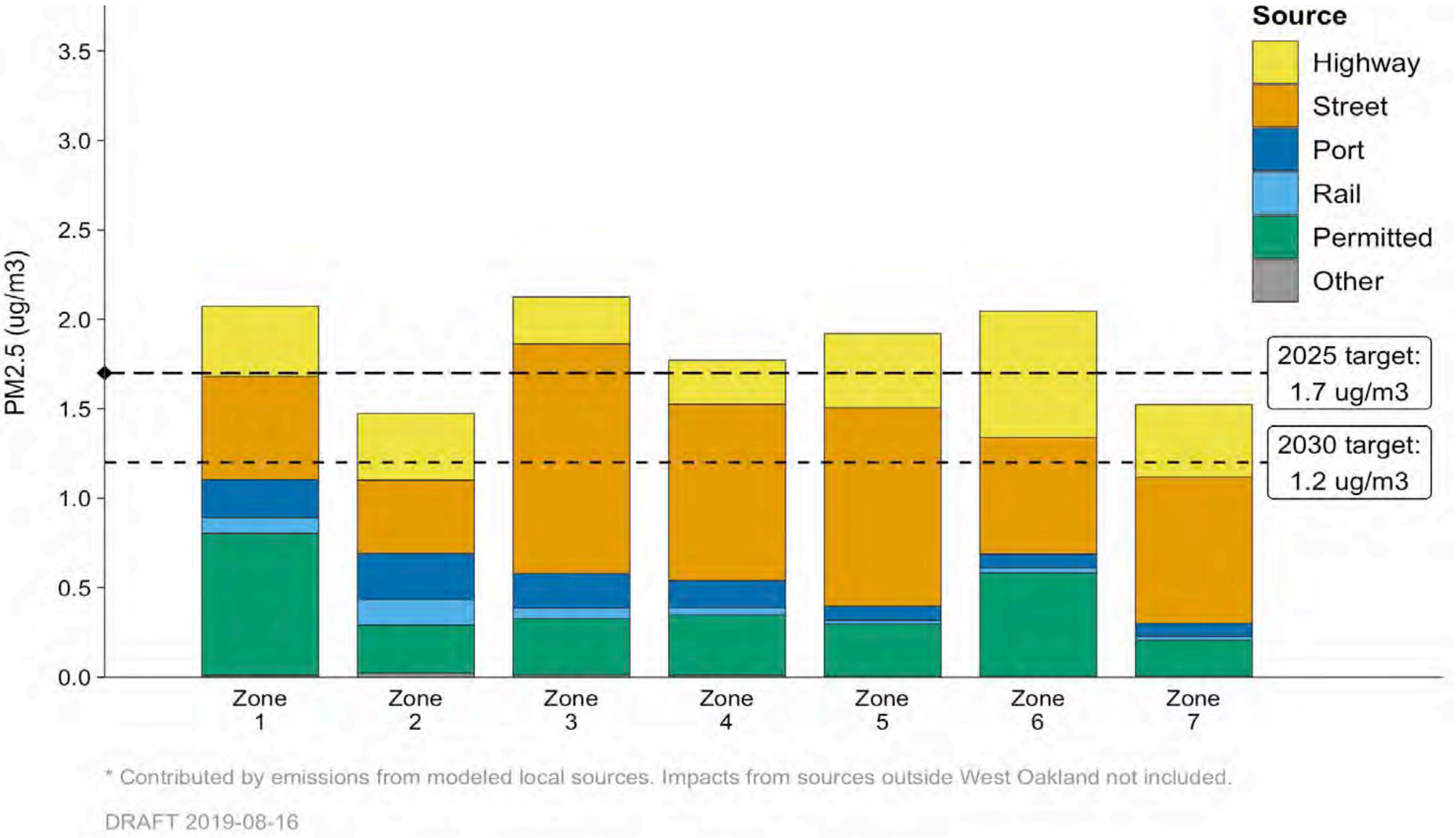


Targets and Source Contributions for $PM_{2.5}$

Targets:

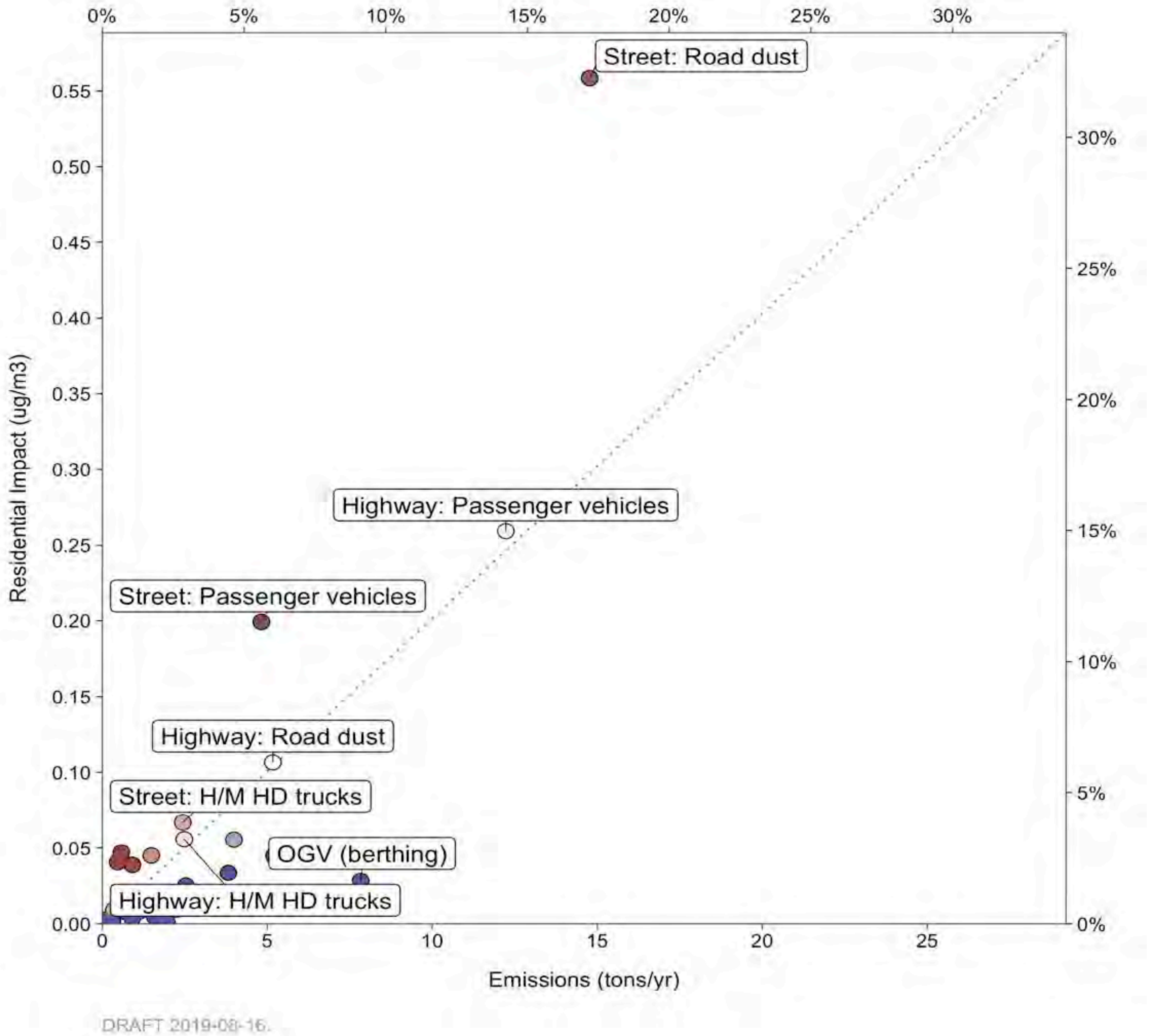
2025 – Today's ***average*** residential neighborhood

2030 – Today's ***cleanest*** residential neighborhood



Impact Per Ton: $PM_{2.5}$ in West Oakland

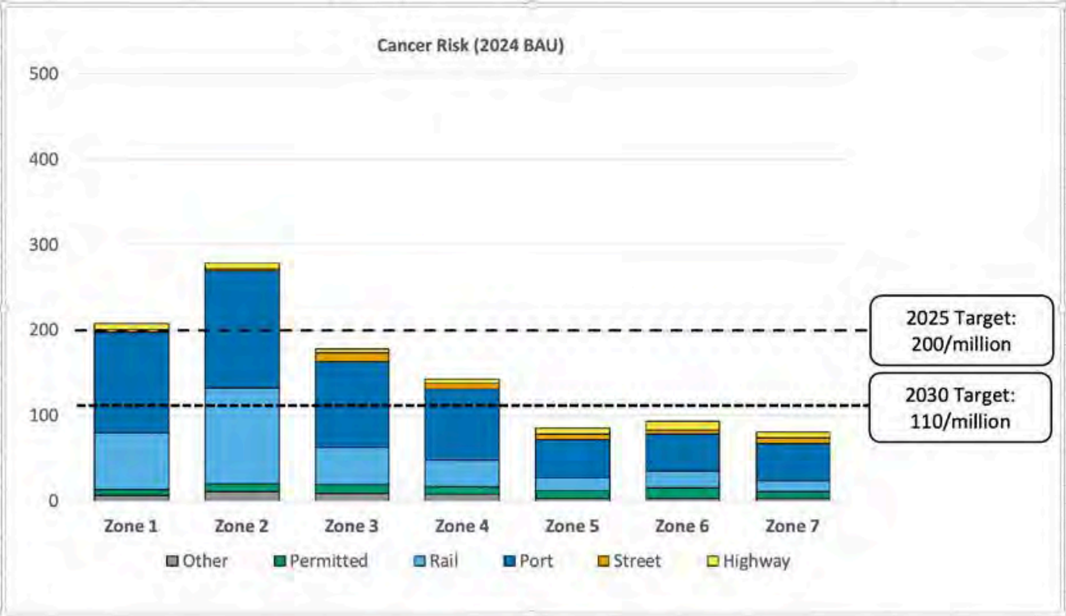
- Circles are modeled local sources
- Red is more impact, blue is less impact
- Percentages are shares of modeled impact
- Some sources have larger **exposure factors** (steeper slopes)



Finding Solutions: “Scenario Tool”

CANCRISK (2024 BAU)

	EMISSIONS		CHANGE		ADJUSTED IMPACTS							
	2017	2024	Relative	Additive	Wt. Avg.	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7
Highway	**1791.3**	**331.6**	-81%		**7.29**	**7.05**	**6.98**	**4.58**	**4.34**	**6.77**	**10.51**	**6.85**
Passenger vehicles	330.7	158.8	-52%		3.38	2.71	2.45	1.87	1.77	3.63	6.61	3.33
Heavy/Medium HD trucks	1391.8	120.3	-91%		2.72	3.15	3.27	1.90	1.79	2.05	2.41	2.43
Light HD trucks	68.8	52.5	-24%		1.19	1.18	1.26	0.81	0.78	1.09	1.50	1.09
Road dust	0.0	0.0	+0%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Street	**1692.2**	**204.3**	-88%		**6.70**	**2.89**	**2.92**	**10.33**	**6.50**	**6.04**	**4.02**	**7.17**
Passenger vehicles	182.6	86.6	-53%		3.58	1.49	1.66	3.82	3.43	3.14	2.05	4.25
Heavy/Medium HD trucks	1434.1	60.4	-96%		1.65	0.62	0.56	4.56	1.72	1.38	0.90	1.45
Light HD trucks	75.5	57.4	-24%		1.47	0.78	0.71	1.94	1.35	1.52	1.07	1.47
Road dust	0.0	0.0	+0%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Port	**11817.2**	**12768.5**	+8%		**64.80**	**118.05**	**136.29**	**100.21**	**83.15**	**45.53**	**44.53**	**43.37**
OGV (maneuvering)	2858.7	4145.1	+45%		15.35	23.38	28.93	22.57	19.60	11.82	11.56	11.32
OGV (berthing)	3212.1	3901.0	+21%		14.12	22.06	27.99	20.79	17.78	10.80	10.77	10.23
Harbor craft	2931.7	2354.8	-20%		20.72	35.16	43.23	33.69	28.25	14.19	13.75	13.61
Dredging	863.9	591.6	-32%		4.24	7.95	9.65	6.86	5.66	2.67	2.67	2.56
Bunkering	209.5	190.4	-9%		1.53	2.62	3.64	2.57	2.10	1.02	0.98	0.97
Drayage trucks	371.8	88.2	-76%		1.04	2.04	1.94	2.95	1.42	0.61	0.54	0.57
Road dust	0.0	0.0	+0%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cargo handling	1176.6	1293.1	+10%		3.77	7.80	11.86	6.16	4.58	2.31	2.19	2.25
Railyard (BNSF)	57.3	61.5	+7%		1.71	4.10	5.56	2.59	1.95	0.99	0.96	0.93
Railyard (OGRE)	135.5	142.6	+5%		2.33	12.95	3.49	2.04	1.81	1.12	1.10	0.92
Rail	**1636.6**	**1462.5**	-11%		**27.12**	**66.14**	**112.12**	**43.75**	**30.97**	**14.86**	**19.22**	**12.95**
Rail lines	810.2	553.8	-32%		9.80	20.93	25.04	14.37	11.14	7.24	11.92	5.83
Railyard (UP)	826.5	908.6	+10%		17.32	45.21	87.09	29.38	19.83	7.62	7.29	7.13
Permitted	**1101.1**	**1184.8**	+8%		**8.42**	**7.46**	**9.69**	**10.83**	**10.09**	**8.68**	**12.61**	**7.79**
Schnitzer (stationary)	822.8	900.4	+9%		4.52	4.92	7.64	8.23	7.26	3.01	2.58	3.29
EBMUD	110.2	117.0	+6%		1.68	1.16	0.83	0.99	1.06	2.94	5.71	1.90
Dynegy	0.6	0.0	-100%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pinnacle Ag	0.0	0.0	+0%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sierra Pacific	0.0	0.0	+0%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CASS	0.0	0.0	-3%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
California Cereal	0.0	0.0	-3%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CA Waste (10th St)	0.0	0.0	+0%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other facilities	167.5	167.5	-0%		2.21	1.38	1.23	1.60	1.77	2.73	4.32	2.60
Other	**1015.7**	**987.2**	-3%		**4.71**	**6.06**	**10.94**	**8.50**	**7.16**	**3.10**	**2.74**	**3.12**
Ferries	695.2	688.1	-1%		2.95	3.73	5.92	5.51	4.62	1.75	1.55	1.88
Schnitzer (ships)	225.2	277.2	+23%		1.56	1.97	3.13	2.76	2.38	1.09	0.97	1.12
Schnitzer (trucks)	8.3	0.3	-97%		0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00
Truck-related businesses	87.0	21.5	-75%		0.20	0.34	1.88	0.22	0.15	0.26	0.22	0.13
	19054.2	**16938.9**	-11%	**-2115.3**	**119.04**	**207.64**	**278.94**	**178.20**	**142.21**	**84.98**	**93.63**	**81.26**



Large Industrial Sources:

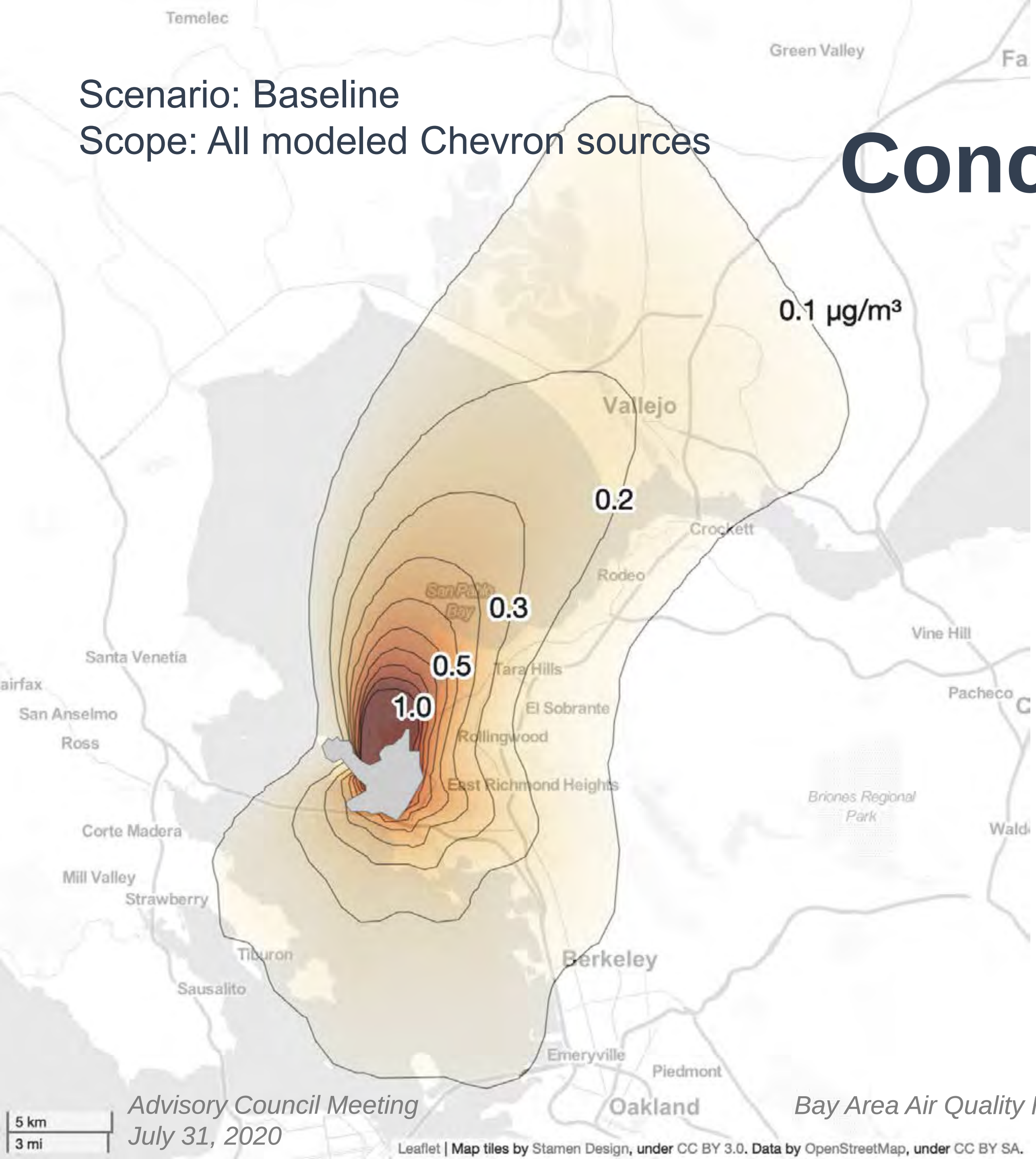
Chevron Richmond Refinery

Modeling Study

- **Scope:** Tracking directly emitted (primary) $PM_{2.5}$
  - From all permitted sources at Chevron, including the Fluidized Catalytic Cracking Unit (FCCU)

- **Scenarios:**
  1. Baseline = existing emissions
  2. Additional FCCU emission reductions

- **Approach:** Track plumes with the CALPUFF air quality model to map concentrations (2016-2018)



Chevron $PM_{2.5}$ Concentration Impacts by Area

- Modeled annual-average, primary $PM_{2.5}$ concentrations from all sources at Chevron
- Baseline scenario
- Measured annual-average $PM_{2.5}$ at nearby San Pablo site: about 8-10 $\mu g/m^3$*

* Excluding 2017-2018 wildfire days; about 8-13 mg/m^3 including wildfire days

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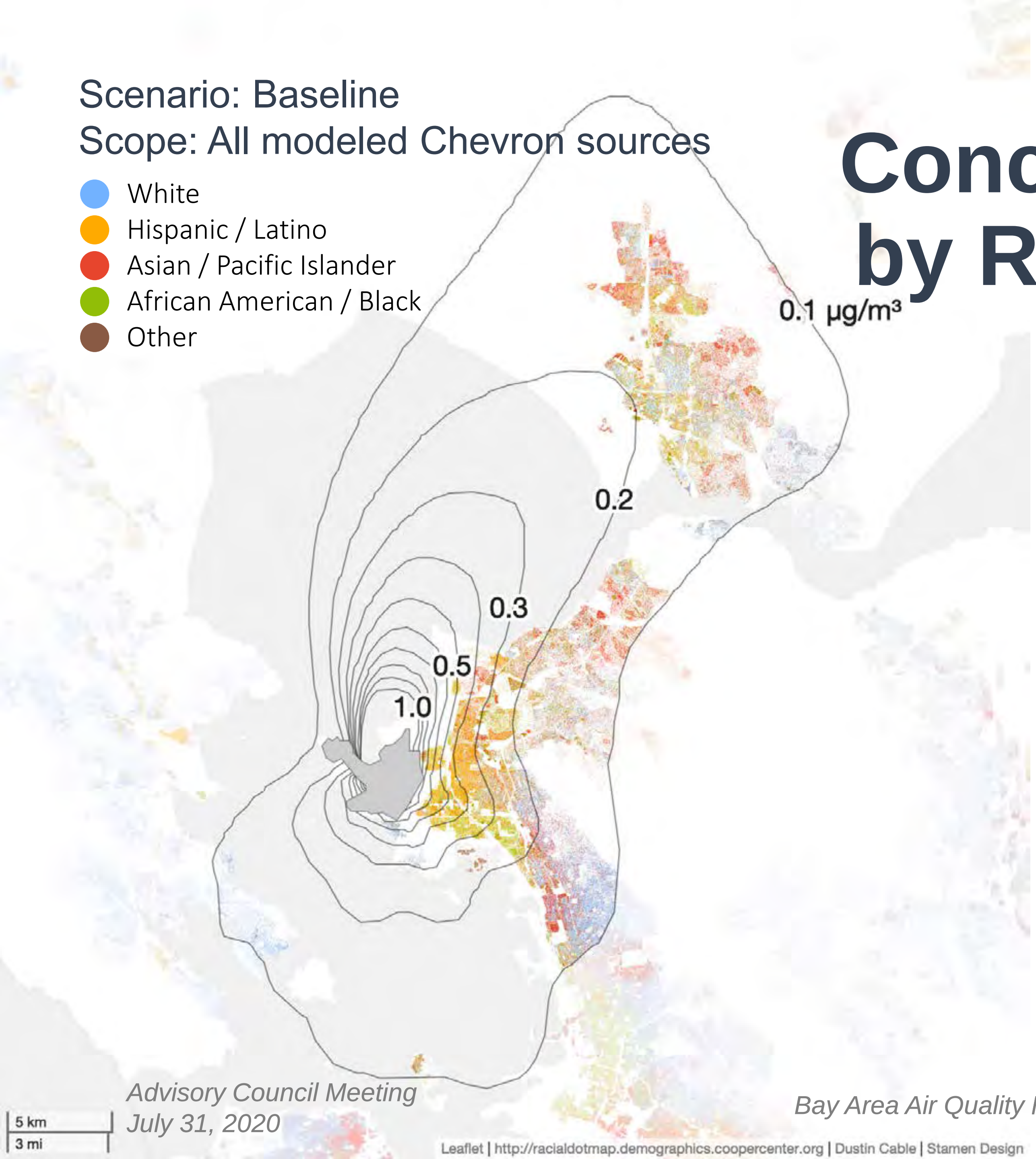
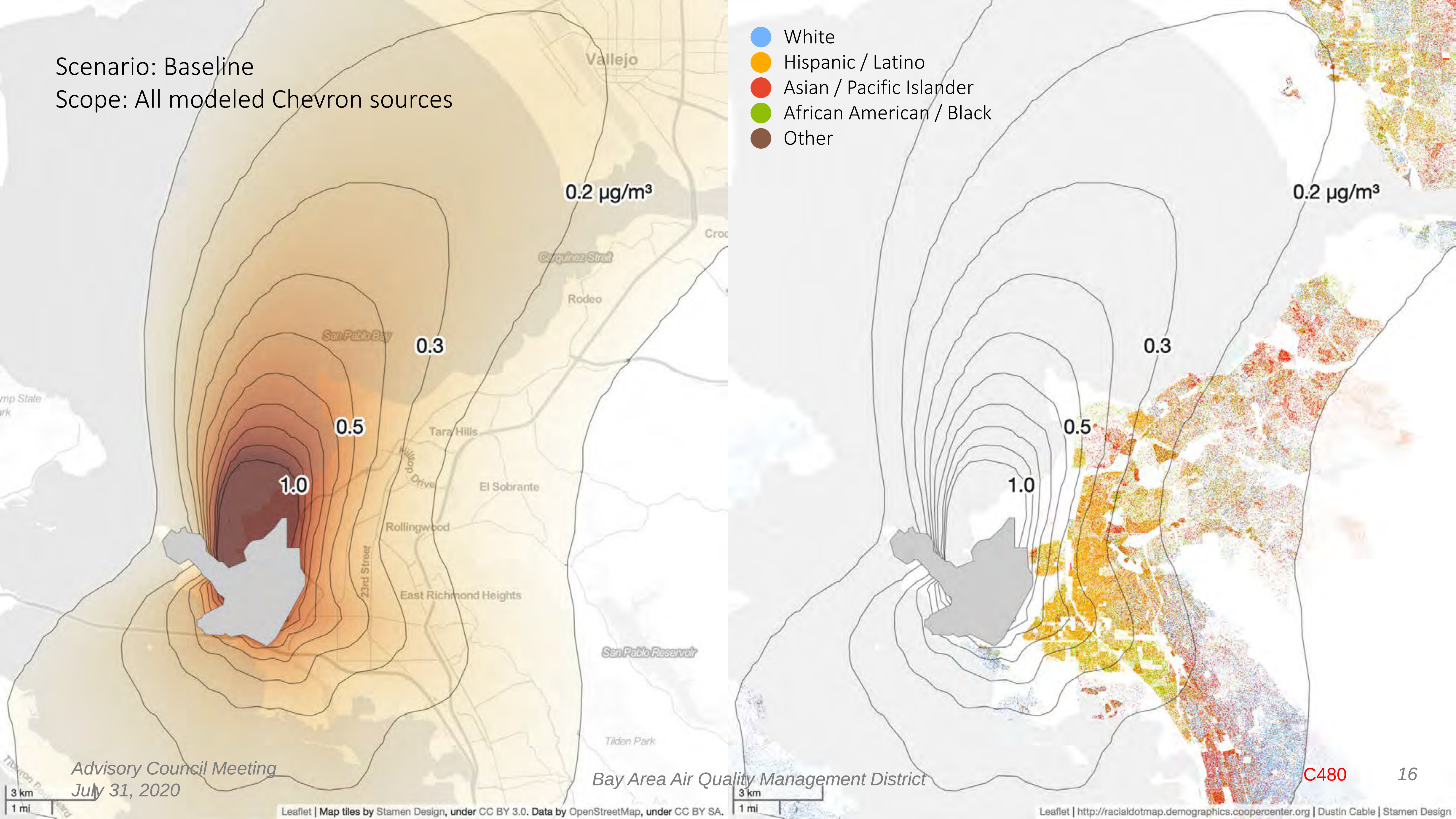


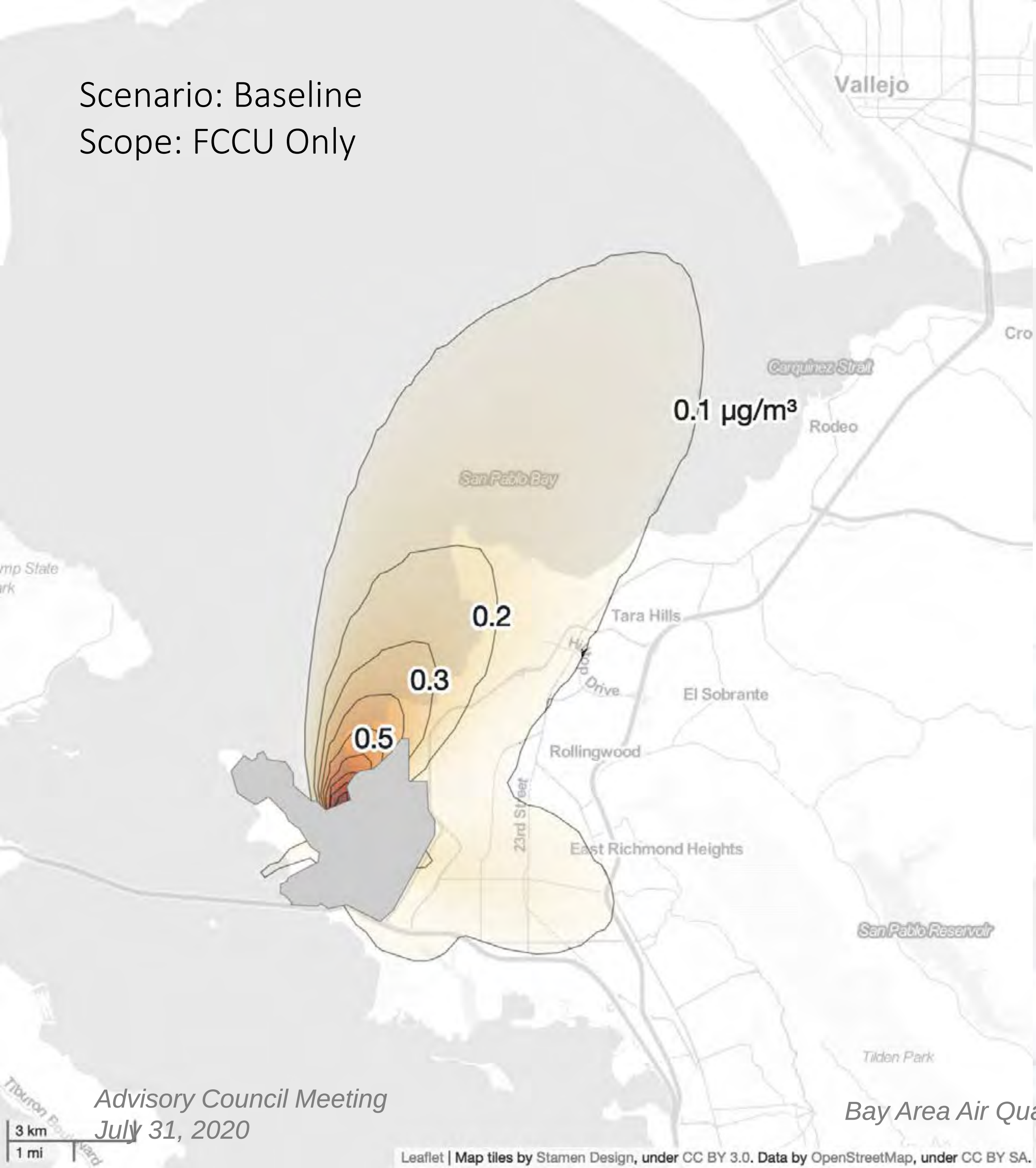
Chevron $PM_{2.5}$ Concentration Impacts by Residents Exposed

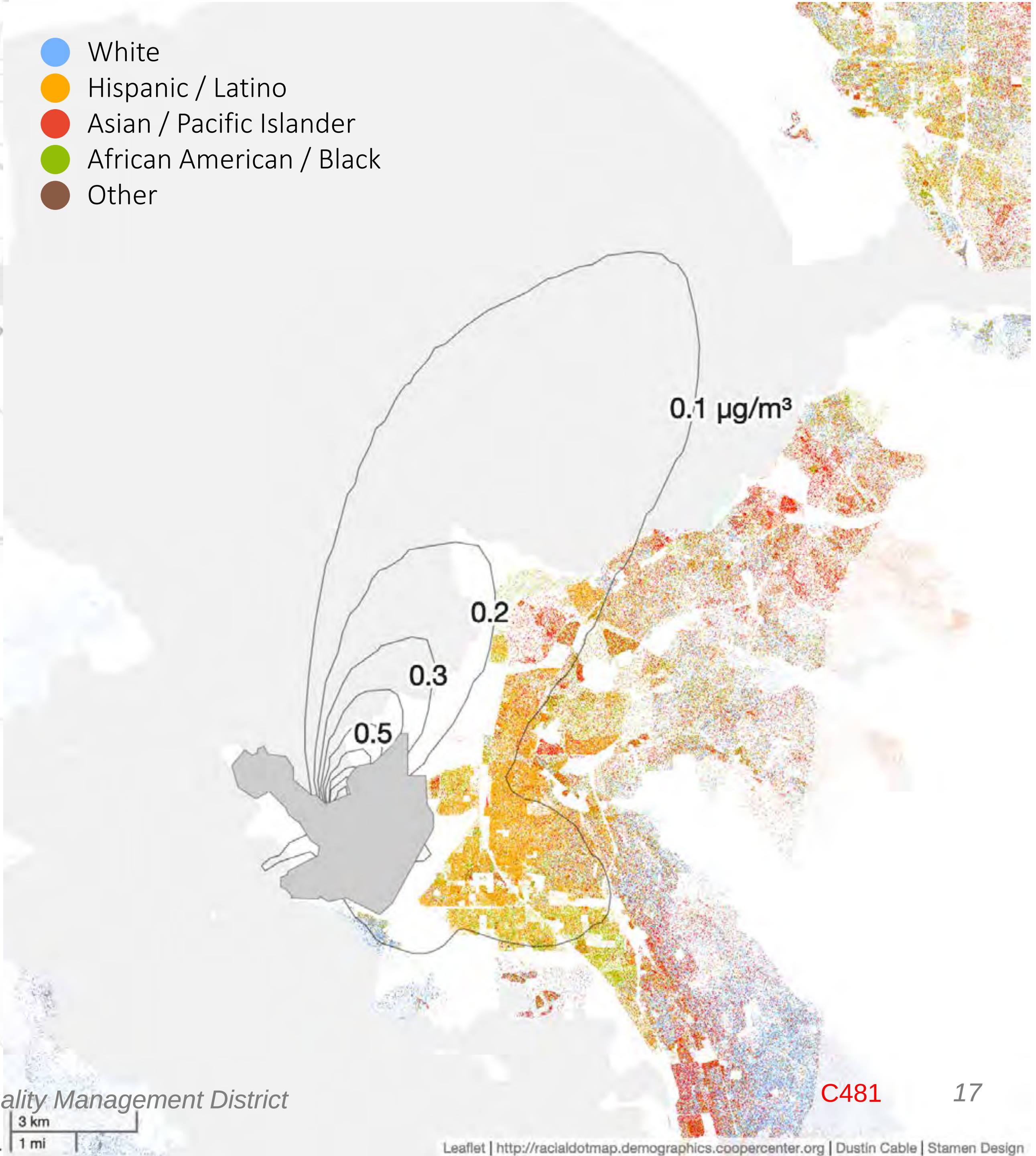
- Each color dot represents one person
- Colors are muted outside the 0.1 $\mu g/m^3$ contour, "the plume"
- Almost half a million people (~449,000) in the plume

Scenario: Baseline
Scope: All modeled Chevron sources



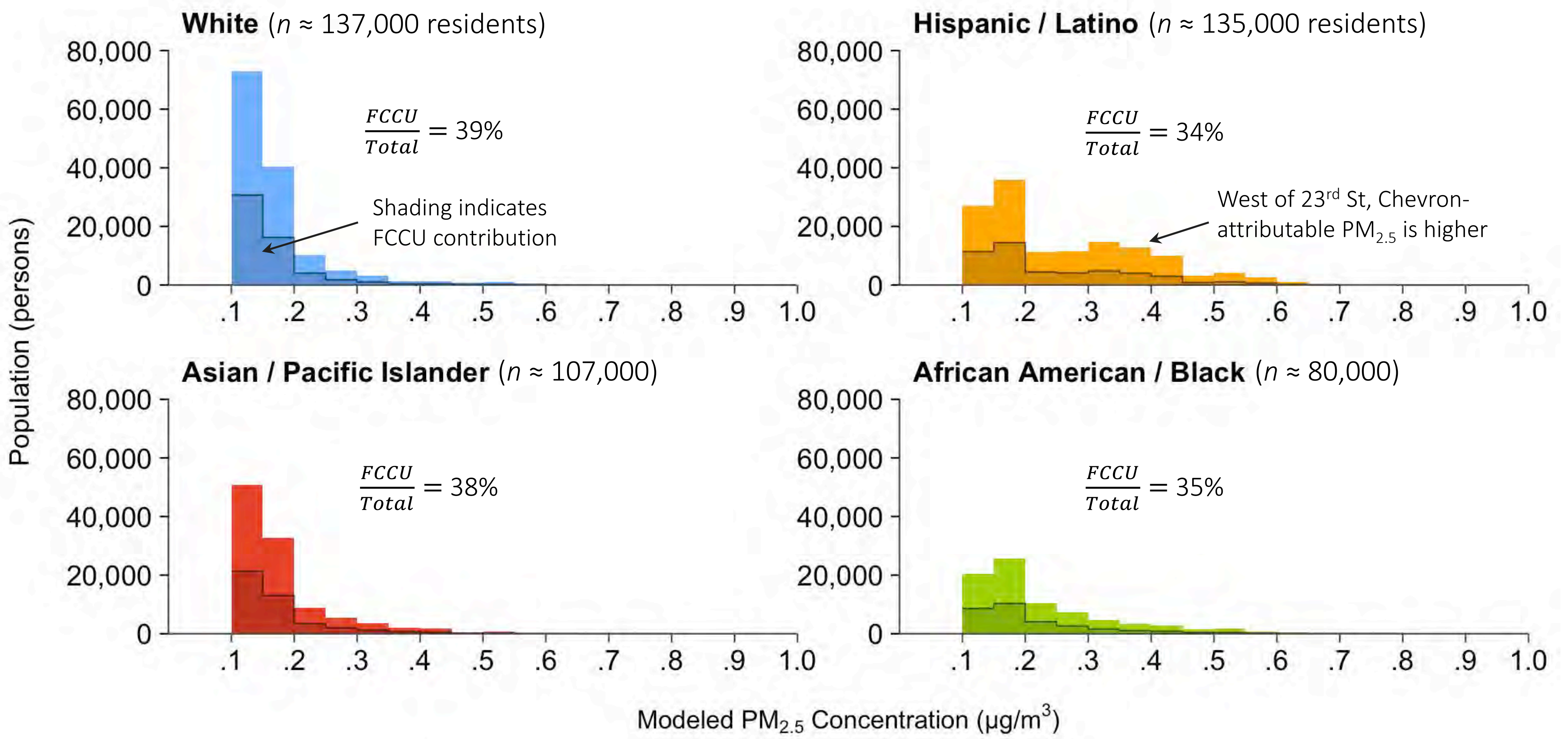
Scenario: Baseline
Scope: FCCU Only





$PM_{2.5}$ Exposures by Race/Ethnicity

Scenario: Baseline
Scope: Census blocks with 0.1 µg/m³ $PM_{2.5}$ or more from Chevron



Next Steps

- Richmond/San Pablo Community Action Plan
- Additional refineries/large industrial facilities
- Methodology for estimating increased adult mortality risk from local sources of $PM_{2.5}$
  - Highlight risks below the federal standard
  - Based on a recent California epidemiological study
  - Development in partnership with US Environmental Protection Agency (EPA) and the Office of Environmental Health Hazards Assessment (OEHHA)

Summary

- Identify source-contributions to impacts
  - What is responsible?
- Assess equity of impacts to inform decision-making
  - Support agency goal of reducing air pollution inequities
- Work toward highlighting health risks from $PM_{2.5}$ exposures below federal standard
  - Develop a risk framework consistent with “no identified safe level of $PM_{2.5}$”

Particulate Matter:
Spotlight on Health Protection

Appendix D: Advisory Council Information

APPENDIX D: AIR DISTRICT WEBPAGES

Information about the Air District, including air quality forecasts, can be found by visiting https://www.baaqmd.gov. In addition, information about the Air District's Spare the Air program can be found by visiting https://www.sparetheair.org.

PARTICULATE MATTER CONFERENCE WEBPAGE

Webcast, audio, presentation materials, reports and meeting minutes for the Advisory Council Particulate Matter Symposium series can be found by visiting https://www.baaqmd.gov/pmconference.

AIR DISTRICT ADVISORY COUNCIL AGENDAS, MINUTES AND MEDIA

Additional information about the Air District's Advisory Council, including Advisory Council member biographies, reports, and meeting information can be found by visiting https://www.baaqmd.gov/about-the-air-district/advisory-council. Meeting dates in the Particulate Matter Symposium series:

- October 28, 2019
- December 9, 2019
- May 12, 2020
- July 31, 2020
- October 9, 2020
- November 9, 2020
- December 3, 2020
- December 16, 2020

APPENDIX D: ADVISORY COUNCIL MEMBER BIOGRAPHIES

The following are the biographies of each of the seven Air District Advisory Council members who participated on the Advisory Council over the course of the particulate matter conference series.

CHAIRPERSON STAN HAYES

Principal Emeritus, ENVIRON (now Ramboll)

Stan Hayes has more than 40 years of experience in environmental science and engineering, with particular emphasis on air impact and health risk analysis for both national ambient air quality standards (NAAQS) and hazardous air pollutant (HAP) purposes, including air quality modeling, strategic and regulatory policy analysis, climate assessment, compliance evaluation, exposure and health risk assessment, and air monitoring and meteorological data analysis.

He is a Fellow of the Air & Waste Management Association, for which he has chaired or co-chaired national and international specialty conferences on climate change, greenhouse gas reporting, and homeland security. Previously, he was a member of the U.S. EPA Science Advisory Board Risk and Technology Review (RTR) Methods Panel.

Chairperson Hayes is the primary author of more than 70 scientific papers and presentations, as well as several hundred technical reports on air-related subjects. He has provided expert testimony before federal, state, and local regulatory agencies and in court. Upon invitation, he has given scientific briefings to members of the California legislature and political leaders elsewhere.

For 25 years, until 2015, he was a Principal with global environmental consulting firm ENVIRON (now Ramboll). He is now emeritus.

Chairperson Hayes earned an M.S. in aeronautics and astronautics and a B.S. in mechanical engineering, both from Stanford University.

VICE CHAIR MICHAEL KLEINMAN

Professor, Environmental Toxicology, Co-Director of the Air Pollution Health Effects Laboratory, Adjunct Professor in College of Medicine, University of California, Irvine

Michael T. Kleinman is UC Irvine Professor of Environmental Toxicology and Co-Director of the Air Pollution Health Effects Laboratory in the Department of Community and Environmental Medicine, and Adjunct Professor in the College of Medicine.

Dr. Kleinman brings to the Advisory Council expertise in the health effects of air pollution on animals and humans, as well as expertise in the development of analytical techniques for assessing biological and physiological responses to exposure to environmental contaminants and for determining concentrations of important chemical species in air.

The research in Dr. Kleinman's laboratory uses immunological and molecular methods to examine the mechanisms by which toxic agents affect the lung and heart. Current studies include the effects of ambient particles on blood pressure and heart rate in sensitive animal models. Other studies examine the link between asthma and environmental exposures to ambient particles near real-world pollutant sources, such as freeways in Los Angeles. Research focuses on mechanisms of cardiopulmonary injury following inhalation of toxic compounds. State-of-the-art methods are used to evaluate the roles of free radicals and oxidative stress in sensitive human volunteers and laboratory animals. In vitro methods are used to evaluate specific mechanisms.

Dr. Kleinman's current studies involve inhalation exposures to manufactured and combustion-generated nanomaterials as fine and coarse particles using state-of-the-art field exposure systems and real-time physiological monitoring methods. Dr. Kleinman's team is also pursuing how these mechanisms affect pathological and physiological changes in the heart and lungs.

Other interests include analytical and atmospheric chemistry, environmental sampling and analysis, and the application of mathematical and statistical methods to environmental and occupational assessments of exposure and risk.

Dr. Kleinman received a Ph.D. in Environmental Health Sciences from New York University.

TIM LIPMAN

Co-Director, UC Berkeley Transportation Sustainability Research Center

Timothy E. Lipman is an energy and environmental technology, economics, and policy researcher and lecturer with the University of California, Berkeley. He is serving as Co-Director for the campus' Transportation Sustainability Research Center (TSRC), based at the Institute of Transportation Studies, and has also served as Director of the U.S. Department of Energy Pacific Region Clean Energy Application Center (PCEAC).

Dr. Lipman's research focuses on electric-drive vehicles, fuel cell technology, combined heat and power systems, biofuels, renewable energy, and electricity and hydrogen energy systems infrastructure. Most of his research projects are related to the transformation of energy systems to support motor vehicles and buildings, examining how both incremental and "leap frog" technologies can be applied to reduce greenhouse gas emissions and other negative environmental and social impacts of energy use. A central concept for his research is that the electrification of the transportation sector can realize synergy with a concentrated effort to reduce the carbon intensity of the electrical grid, yielding benefits for the electricity sector as well as the expanded use of electricity, hydrogen, and biofuels.

Dr. Lipman received his Ph.D. in Environmental Policy Analysis with the Graduate Group in Ecology at UC Davis (1999). He also has received an M.S. degree in the technology track of the Graduate Group in Transportation Technology and Policy, also at UC Davis (1998), and a B.A. from Stanford University (1990).

JANE C.S. LONG

Associate Director for Energy and Environment, retired, Lawrence Livermore National Lab

Jane Long retired from Lawrence Livermore National Laboratory, where she was the Principal Associate Director at Large, Fellow in the LLNL Center for Global Strategic Research, and the Associate Director for Energy and Environment. She is currently a chairperson of the California Council on Science and Technology's committees on California's Energy Future and assessment of hydraulic fracturing. Her current work involves strategies for dealing with climate change, including reinvention of the energy system, geoengineering, and adaptation.

Dr. Long was the Dean of the Mackay School of Mines, University of Nevada, Reno, and Department Chair for the Energy Resources Technology and the Environmental Research Departments at Lawrence Berkeley National Lab.

Dr. Long is a fellow of the American Association for the Advancement of Science, an Associate of the National Academies of Science (NAS), and a Senior Fellow and council member of the California Council on Science and Technology (CCST) and the Breakthrough Institute.

She holds a bachelor's degree in engineering from Brown University and a master's and Ph.D. from UC Berkeley.

DR. LINDA RUDOLPH

Director, Center for Climate Change and Health

Linda Rudolph is a public health physician with more than four decades of experience in local and state government and non-profit organizations. Currently, Dr. Rudolph is the Director of the Center for Climate Change and Health at the Public Health Institute, where her work has focused on building capacity in local health departments to integrate climate change into public health practice and on supporting health professionals as climate and health champions. She previously served as Deputy Director for Chronic Disease Prevention and Health Promotion in the California Department of Public Health. At CDPH, Dr. Rudolph was the founding chair of the California Health in All Policies Task Force under the auspices of the Strategic Growth Council.

Dr. Rudolph has also served as the Health Officer and Public Health Director for the City of Berkeley, Chief Medical Officer for Medi-Cal Managed Care, and Medical Director for the California Workers' Compensation Division. She is board-certified in Occupational Medicine and worked for many years in occupational health, initially with the Oil, Chemical, and Atomic Workers' International Union.

She received her M.D. from the University of California, San Francisco, and her M.P.H. and B.A. from UC Berkeley.

GINA M. SOLOMON, M.D., M.P.H.

Clinical Professor, Division of Occupational and Environmental Medicine, UCSF;
Principal Investigator, Public Health Institute

Gina Solomon is a Clinical Professor in the Division of Occupational and Environmental Medicine at the University of California San Francisco (UCSF) and a Principal Investigator at the Public Health Institute in Oakland, CA. She served as the Deputy Secretary for Science and Health at the California Environmental Protection Agency (CalEPA) from 2012 to 2017, and as a senior scientist at the Natural Resources Defense Council from 1996 to 2012. She was also the director of the occupational and environmental medicine residency program at UCSF, and the co-director of the UCSF Pediatric Environmental Health Specialty Unit.

Dr. Solomon's work has spanned a wide array of areas, including children's environmental health, the health effects of diesel exhaust, reproductive toxicity of environmental chemicals, cumulative impacts and environmental justice, and the use of novel data streams to screen chemicals for toxicity.

She has also done work in exposure science for air pollutants, pesticides, mold, and heavy metals. She conducted environmental exposure studies in Louisiana in the aftermath of Hurricane Katrina and during the Gulf oil spill, published the first study documenting children's exposure to diesel exhaust inside school buses, and served on the Scientific Guidance Panel for Biomonitoring California, a statewide program to measure contaminants in people. Dr. Solomon has also done work on the health effects of climate change. She published a study documenting the large spike in emergency department visits in California during the 2006 heat wave, and has published work documenting the health costs of climate-related events. She works to educate health care professionals and students about the health effects of climate change.

During her tenure at CalEPA, Dr. Solomon advised the Secretary on a wide range of issues related to chemicals in consumer products, toxic air contaminants, drinking water contaminants, and pesticides. She was also involved in recommending policy changes in the aftermath of the Chevron Richmond refinery fire. She chaired the California Interagency Refinery Task Force and successfully spearheaded regulations to improve refinery safety in California. Dr. Solomon has served on multiple boards and committees of the National Academies of Science, the U.S. EPA Science Advisory Board, and the National Toxicology Program's Board of Scientific Counselors. She also serves on the U.S. EPA Board of Scientific Counselors Chemical Safety for Sustainability subcommittee.

Dr. Solomon received her bachelor's degree from Brown University, her M.D. from Yale University, and completed her M.P.H. and her residency and fellowship training in internal medicine and occupational and environmental medicine at Harvard University.

SEVERIN BORENSTEIN

E.T. Grether Professor of Business Administration and Public Policy, Haas School of Business; Faculty Director of the Energy Institute at Haas.

Severin Borenstein is E.T. Grether Professor of Business Administration and Public Policy at the Haas School of Business and Faculty Director of the Energy Institute at Haas. He is an affiliated professor in the Agricultural and Resource Economics department and the Energy and Resources Group at UC Berkeley. He is also Director emeritus of the University of California Energy Institute. Borenstein has been a research associate of the National Bureau of Economic Research (NBER) since 1992 and served as co-Director of NBER's research project on e-commerce in 1999-2000. Prior to coming to Haas in 1996, he taught at the University of Michigan and University of California at Davis. He has won awards for undergraduate and graduate teaching, and in 2005 received U.C. Berkeley's Distinguished Faculty Mentor Award for graduate student mentoring.

Borenstein's research focuses broadly on business competition, strategy, and regulation. He has published extensively on airline, oil and gasoline, and electricity markets, as well as on insurance, e-commerce, mining, natural gas, and other industries. Borenstein's recent research has focused on competition and profitability in the airline industry, the impact of oil prices on gasoline markets, alternative models of retail electricity pricing, and the economics of renewable energy and climate change. He is a past editor of the *Journal of Industrial Economics*, past associate editor of *The Review of Economics and Statistics* and past member of the editorial boards of *American Economic Journal: Economic Policy, Journal of Economic Literature*, and *Journal of the Association of Environmental and Resource Economists*.

During 1997-2003, Borenstein was a member of the Governing Board of the California Power Exchange. He served on the California Attorney General's gasoline price taskforce in 1999-2000. In 2010-11, Borenstein was a member of U.S. Secretary of Transportation Ray LaHood's Future of Aviation Advisory Committee. In 2012-13, he served on the Emissions Market Assessment Committee, which advised the California Air Resources Board on the operation of California’s Cap and Trade market for greenhouse gases. In 2014, he was appointed to the California Energy Commission’s Petroleum Market Advisory Committee, which he chaired from 2015 until the Committee was dissolved in 2017. From 2015 to May 2020, he served on the Advisory Council of the Bay Area Air Quality Management District. In January 2019, he was appointed to the Governing Board of the California Independent System Operator.

Borenstein has received the 2005 Distinguished Service Award from the Public Utility Research Center at the University of Florida, the Power Association of Northern California’s 2014 Achievement Award, the Industrial Organization Society’s 2015 Distinguished Fellow Award and the International Association for Energy Economics’ 2015 Award for Outstanding Contributions to the Profession.

Borenstein grew up in Oakland and Berkeley, California, where he attended public schools and graduated from Berkeley High School. He received his undergraduate degree from U.C. Berkeley and Ph.D. in economics from MIT.

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

RESOLUTION NO. 2018 - 08

**A Resolution of the Board of Directors of the
Bay Area Air Quality Management District
Adopting Expedited BARCT Implementation Schedule;
and
Certifying a CEQA Environmental Impact Report for the Project**

RECITALS

WHEREAS, Health & Safety Code section 40920.6 requires each air district that is a nonattainment area for one or more air pollutants to adopt, on or before January 1, 2019, an expedited schedule for implementation of best available retrofit control technology (BARCT) by the earliest feasible date, but no later than December 31, 2023;

WHEREAS, the San Francisco Bay Area Air Basin is designated by the California Air Resources Board as a nonattainment area for the state ambient eight-hour ozone standard of 0.070 ppm; the state ambient one-hour ozone standard of 0.09 ppm; the state ambient annual arithmetic mean particulate matter standard of 20 $\mu g/m^3$ for PM10; the state 24-hour particulate matter standard of 50 $\mu g/m^3$ for PM10; and the state ambient annual arithmetic mean particulate matter standard of 12 $\mu g/m^3$ for PM2.5;

WHEREAS, the Bay Area Air Quality Management District ("District") is therefore required by Health and Safety Code section 40920.6 to adopt an expedited schedule for implementation of BARCT;

WHEREAS, District staff have prepared the Expedited BARCT Implementation Schedule, as set forth in Attachment A hereto and incorporated herein by reference (the "BARCT Schedule"), in order to implement the provisions of Health & Safety Code section 40920.6;

WHEREAS, District staff developed a concept paper describing the BARCT determination process and potential rule development projects included in the Expedited BARCT implementation schedule and published the concept paper and rule development scope papers on the Air District website on May 24, 2018 and accepted written comments on the documents through June 15, 2018;

WHEREAS, on May 21, 2018 and July 30, 2018, District staff discussed the draft rule with the Stationary Source Committee of the Board of Directors;

WHEREAS, District staff also discussed the BARCT Schedule with representatives from community and environmental groups, as well as representatives from affected facilities and industries;

WHEREAS, based on comments received on the concept paper and rule development scope papers, and in discussions with community, environmental, and industry groups and representatives, District staff prepared an Initial Staff Report and revised rule development scope papers, which District staff published on the District website on September 5, 2018, and accepted comments on these documents through October 5, 2018;

WHEREAS, on September 5, 2018, District staff discussed the BARCT Schedule with the Board of Directors;

WHEREAS, District staff considered input received on the Initial Staff Report and revised rule development scope papers, and continued to conduct further analysis, coordinate with the California Air Resources Board and other air districts, and solicit public input, and based on the input so received and its own further analysis, District staff prepared the proposed BARCT Schedule and October 2018 Staff Report, which District staff published on the District website on October 23, 2018, and accepted comments on these documents through December 7, 2018;

WHEREAS, District staff have reviewed and considered all of the comments received and have revised the BARCT Schedule and associated documents accordingly, as reflected in the Final BARCT Schedule and final rule development scope papers, and have prepared written responses to the comments that have been provided to the Board of Directors for review;

WHEREAS, District staff has prepared and presented to the public and to the Board of Directors a detailed Final Staff Report describing the purpose of and need for the BARCT Schedule, the development of the BARCT Schedule, how the BARCT Schedule will comply with California Health and Safety Code section 40920.6, and how issues raised by members of the public are addressed by the BARCT Schedule, which Final Staff Report has been considered by this Board and is incorporated herein by reference;

WHEREAS, on October 23, 2018, Air District staff published in newspapers and distributed and published on the Air District's website a notice of a public hearing to be held on December 19, 2018 to consider adoption of the BARCT Schedule, and the notice included a request for public comments and input on the BARCT Schedule;

WHEREAS, the Board of Directors held a public hearing on December 19, 2018, to consider the BARCT Schedule, in accordance with all provisions of law, at which meeting District staff presented the BARCT Schedule and proposed it for adoption;

WHEREAS, at the public hearing, the subject matter of the BARCT Schedule was discussed with interested persons in accordance with all provisions of law;

WHEREAS, at the public hearing and prior to adopting the BARCT Schedule, the Board of Directors took into account the local public health and clean air benefits to the surrounding community; the cost-effectiveness of each control option; and the air quality and attainment benefits of each control option, as required by subdivision (d) of Health and Safety Code section 40920.6;

WHEREAS, the Board of Directors has determined that, as required by paragraph (2) of subdivision (c) of Health & Safety Code section 40920.6, the BARCT Schedule will apply to each industrial source within the District that, as of January 1, 2017, was subject to a market-based compliance mechanism adopted by the state board pursuant to subdivision (c) of Health and Safety Code section 38562 (the "Cap and Trade Program");

WHEREAS, the Board of Directors has determined that, as required by paragraph (3) of subdivision (c) of Health & Safety Code section 40920.6, the BARCT Schedule will give highest priority to those permitted units that have not modified emissions-related permit conditions for the greatest period of time, and will not apply to any emissions unit that has implemented BARCT due to a permit revision or a new permit issuance since 2007;

WHEREAS, the BARCT Schedule complies with the applicable terms and conditions of Health & Safety Code section 40920.6 requiring certain air districts to adopt an expedited schedule for the implementation of best available retrofit control technology, including but not limited to the provisions referred to above;

WHEREAS, the proposed adoption of the BARCT Schedule constitutes a "project" pursuant to the California Environmental Quality Act ("CEQA") (Public Resources Code §§ 21000 et seq.);

WHEREAS, the District is the lead agency for this project under CEQA Guidelines section 15050 (14 California Code of Regulations section 15050);

WHEREAS, District staff caused to be prepared an environmental impact report ("EIR") analyzing the potential environmental impacts of the BARCT Schedule in accordance with the requirements of CEQA;

WHEREAS, the District prepared a Notice of Preparation and an Initial Study (NOP/IS) for the Draft Environmental Impact Report (DEIR) for the Expedited BARCT Implementation Schedule, which the District distributed in accordance with CEQA Guidelines section 15082 and published on the District's website on August 7, 2018 for review and comment, and accepted written comments on the NOP/IS through September 7, 2018;

WHEREAS, the District noticed and conducted a scoping meeting in accordance with CEQA Guidelines section 15082, which meeting occurred on August 24, 2018;

WHEREAS, the District received two written comment letters regarding the NOP/IS during the 31-day public review and comment period;

WHEREAS, District staff considered all of the comments received and, taking due account of the comments and input received in the course of the scoping and consultation process, caused a Draft EIR to be prepared and publicized for review and comment by interested members of the public and others as required by CEQA;

WHEREAS, on or before October 23, 2018, the District published the Draft EIR and provided notification to the public and to other interested parties, via newspaper advertisement, email notifications, and on the District's website (among other means), that the Draft EIR was complete and was available for public review and comment;

WHEREAS, the public notification materials published by the District (i) informed the public that the Draft EIR was available on the District website and by request to the District and (ii) invited public comments on the Draft EIR during the period from October 23, 2018 through December 7, 2018;

WHEREAS, the District received one written comment letter regarding the Draft EIR during the 45-day public review and comment period;

WHEREAS, District staff considered all of the comments received and has prepared a Final EIR, which incorporates certain revisions to the Draft EIR based on the comments received as well as other considerations, and which includes copies of the comments received as well as written responses to the comments prepared by District staff;

WHEREAS, the Final EIR, a copy of which is attached hereto and incorporated herein by reference, was presented to the Board of Directors and proposed for certification by the Board of Directors at a public meeting of the Board of Directors on December 19, 2018;

WHEREAS, none of the revisions to the Draft EIR include any significant new information that would require recirculation of the Draft EIR under CEQA Guidelines section 15088.5;

WHEREAS, the EIR found that the BARCT Schedule will have the potential to create a significant adverse impact on air quality that comes from construction emissions and cannot be mitigated to a level that is less than significant, as described in Chapter 3.2 of the Final EIR;

WHEREAS, the EIR found that the BARCT Schedule will have the potential to create a significant adverse impact on water demand that cannot be mitigated to a level that is less than significant, as described in Chapter 3.4 of the Final EIR;

WHEREAS, the EIR discussed potential mitigation measures for construction emission impacts as specified in Section 3.2.5 of Chapter 3.2 and water demand impacts in Section 3.4.5 of Chapter 3.4 which might reduce the significant air quality and water demand impacts identified in the EIR, as explained in Section 1.4 of Chapter 1 of the Final EIR, but those mitigation measures are within the responsibility and jurisdiction of public agencies other than the District, and such measures have been or could be adopted by such other agencies;

WHEREAS, substantial evidence in the record demonstrates that approval of the BARCT Schedule involves specific considerations related to the need identified by the Legislature to reduce air pollution and protect public health and the environment through the expeditious implementation of best available retrofit control technology at industrial sources subject to the Cap and Trade Program, and the District's obligation to do so under Health and Safety Code section 40920.6, that make the alternatives identified in the EIR that would avoid or substantially lessen the significant air quality and water demand impacts infeasible, as explained in Section 1.5 of Chapter 1 of the Final EIR;

WHEREAS, substantial evidence in the record demonstrates that the significant and unavoidable impacts to air quality during construction and from increases in water demand are acceptable as provided in CEQA Guidelines section 15093 because the public health and air quality benefits from the BARCT Schedule outweigh the Schedule's significant unavoidable impacts;

WHEREAS, this matter has been duly noticed and heard in compliance with applicable requirements of the Health and Safety Code and the Public Resources Code;

WHEREAS, the documents and other materials that constitute the record of proceedings on which the BARCT Schedule and the Final EIR are based are located at the Bay Area Air Quality Management District, 375 Beale Street, Suite 600, San Francisco, 94105, and the custodian for these documents is Marcy Hiratzka, Clerk of the Boards;

WHEREAS, District staff provided copies of (i) the BARCT Schedule, and (ii) the Final EIR, including the comments received on the Draft EIR and staff's responses thereto, to each of the members of the Board of Directors for their review and consideration in advance of the public meeting of the Board of Directors on December 19, 2018;

WHEREAS, District staff has recommended that the Board of Directors adopt the BARCT Schedule;

WHEREAS, the Board of Directors concurs with recommendations of District staff regarding the BARCT Schedule;

WHEREAS, District staff has recommended that the Board of Directors certify the Final EIR, which was prepared as the CEQA document for the BARCT Schedule, as being in compliance with all applicable requirements of CEQA;

WHEREAS, the Board of Directors concurs with recommendations of District staff regarding the Final EIR for the BARCT Schedule;

RESOLUTION

NOW THEREFORE, BE IT RESOLVED, that the Board of Directors of the Bay Area Air Quality Management District does hereby certify and adopt the Final EIR pursuant to CEQA for the BARCT Schedule.

BE IT FURTHER RESOLVED that in support of and as part of its certification and adoption of the Final EIR for the BARCT Schedule, the Board of Directors hereby makes the following findings and certifications:

1. The Final EIR for the BARCT Schedule has been prepared in accordance with all requirements of CEQA.

2. The Final EIR for the BARCT Schedule was duly presented to the Board of Directors for its consideration in accordance with CEQA and other applicable legal requirements.

3. The Board of Directors has reviewed and considered the information in the Final EIR and the evidence in the record described and summarized in the Final EIR, including but not limited to (i) the Final EIR's conclusion that the BARCT Schedule will have significant air quality and water demand impacts as described in the Final EIR, (ii) the mitigation measures proposed to mitigate the significant air quality and water demand impacts outlined in the Final EIR, and (iii) the alternatives considered to avoid or substantially lessen the significant air quality and water demand impact that are evaluated in the Final EIR.

4. The Board of Directors specifically approves the mitigation measures outlined in the Final EIR, which are incorporated by reference as if fully set forth herein, to mitigate the BARCT Schedule's significant air quality and water demand impacts. No additional feasible mitigation measures have been identified that can further mitigate the significant impacts.

5. The Board of Directors finds that the mitigation measures for construction emission impacts discussed in Section 3.2.5 of Chapter 3.2 and water demand impacts in Section 3.4.5 of Chapter 3.4 of the Final EIR, as explained in Section 1.4 of Chapter 1 of the Final EIR, are within the responsibility and jurisdiction of public agencies other than the District, and such measures have been or could be adopted by such other agencies.

6. The analysis of alternatives set forth in Chapter 4 of the Final EIR has provided the Board of Directors with a basis for considering ways in which the significant air quality and water demand impacts could be avoided or substantially lessened while still achieving all or most of the Plan's objectives. The alternatives analysis in the Final EIR is sufficient to carry out the purposes of such analysis under CEQA.

7. The Board of Directors finds that there is a pressing need to reduce air pollution and to protect public health and the environment, and to comply with the mandate of the Legislature set forth in subdivisions (c) and (d) of Health and Safety Code section 40920.6, which the BARCT Schedule addresses. The Board of Directors finds that the benefits that will be obtained from the BARCT Schedule in addressing these needs constitute specific considerations that make the alternatives identified in the Final EIR to avoid or significantly lessen the BARCT Schedule's significant air quality and water demand impacts infeasible. In making this finding, the Board of Directors has considered and agrees with the reasons supporting the finding as set forth in Section 1.5 of Chapter 1 of the Final EIR, which are incorporated by reference as if fully set forth herein and which the Board of Directors adopts as its own.

8. The Final EIR (including responses to comments) is complete, adequate and in full compliance with CEQA as a basis for considering and acting upon the BARCT Schedule.

9. The Final EIR reflects the independent judgment and analysis of the Bay Area Air Quality Management District.

10. The Board of Directors has exercised its own independent judgment in reviewing, considering and certifying the Final EIR and in making the findings and certifications set forth in this Resolution, which reflects the independent judgment and analysis of the Board of Directors.

BE IT FURTHER RESOLVED that the Board of Directors of the Bay Area Air Quality Management District does hereby adopt the Expedited BARCT Implementation Schedule, a copy of which is attached hereto and incorporated herein by reference.

BE IT FURTHER RESOLVED that in support of and as part of its adoption of the BARCT Schedule, the Board of Directors hereby makes the following findings and certifications:

1. The BARCT Schedule provides for the implementation by the earliest feasible date, which in any event will be no later than December 31, 2023, of best available retrofit control technology at each industrial source within the District that, as of January 1, 2017, was subject to the Cap and Trade Program.

2. The BARCT Schedule will give highest priority to those permitted units that have not modified emissions-related permit conditions for the greatest period of time and will not apply to any emissions unit that has implemented BARCT due to a permit revision or a new permit issuance since 2007.

3. At the public hearing and prior to adopting the BARCT Schedule, the Board of Directors took into account the local public health and clean air benefits to the surrounding community; the cost-effectiveness of each control option; and the air quality and attainment benefits of each control option.

4. The Board of Directors' approval of the BARCT Schedule is based on and supported by (among other things) the Board's consideration of the Final EIR for the BARCT Schedule.

5. The Board of Directors has balanced the benefits of the BARCT Schedule against its unavoidable environmental risks in determining whether to approve the BARCT Schedule. The Board of Directors finds that the BARCT Schedule's benefits in reducing air pollution and protecting public health, and in fulfilling the specific mandate of the Legislature to adopt a BARCT Schedule as set forth in subdivisions (c) and (d) of Health and Safety Code section 40920.6, outweigh the adverse impacts from air quality impacts from construction emissions and increases in water demand from operation of air pollution control equipment that are expected to result from implementing the BARCT Schedule. The Board of Directors therefore finds that these significant impacts from the BARCT Schedule are acceptable pursuant to Section 15093 of the CEQA Guidelines, 14 Cal. Code Regs. § 15093; and makes this finding as a "Statement of Overriding Considerations" pursuant to Section 15093. The specific reasons supporting this finding and Statement of Overriding Considerations are as follows:

a. The Board of Directors has considered the air quality impacts associated with construction of air pollution control equipment to comply with the BARCT Schedule, which would be expected to be, in the worst-case, 70.5 pounds per day of reactive organic gases (in light of Bay Area emissions of approximately 273 tons per day), 347.7 pounds per day of carbon monoxide (in light of Bay Area emissions of approximately 1327 tons per day), 395.2 pounds per day of nitrogen oxides (in light of Bay Area emissions of approximately 316 tons per day), 1.5 pounds per day of sulfur oxides (in light of Bay Area emissions of approximately 21 tons per day), 135.6 pounds per day of PM10 (in light of Bay Area emissions of approximately 105 tons per day), and 81.3 pounds per day of PM2.5 (in light of Bay Area emissions of approximately 45 tons per day).

b. The Board of Directors has considered the water demand increase of approximately 1.74 million gallons per day that is expected to result from the BARCT Schedule, which the Board of Directors has evaluated in light of the significant adverse impact the increase will have on the region's water supply resources as described in Chapter 3.4 of the Final EIR, and also in light of the Bay Area's total water usage of over one billion gallons per day, as well as the fact that the recent drought that has made water supply issues an especially acute concern over the past few years is now over.

c. The Board of Directors has considered that, as explained in Section 1.4 of Chapter 1 and in Chapter 4 of the Final EIR, the air quality impacts associated with construction of air pollution control equipment and the water demand increase associated with the operation of air pollution control equipment are unavoidable consequences of the adoption of an expedited schedule for the implementation of best available retrofit control technology at sources subject to the Cap and Trade program in the District, and that the District's adoption of such a schedule is required under subdivisions (c) and (d) of Health and Safety Code section 40920.6, which were enacted as part of Assembly Bill 617, which was signed by the Governor in July 2017 and is intended ". . . to reduce emissions of toxic air contaminants and criteria pollutants in communities affected by a high cumulative exposure burden."

d. In addition to the reasons outlined in subparagraphs a.-c. above, the Board of Directors has reviewed and considered the more detailed summary of reasons why the BARCT Schedule's benefits in reducing air pollution and protecting public health outweigh the BARCT Schedule 's adverse air quality and water demand impacts set forth in Section 1.4 of Chapter 1 of the Final EIR for the BARCT Schedule. The Board of Directors agrees with the reasons set forth therein, and it adopts those reasons as its own and incorporates them by reference as if fully set forth herein as specific reasons supporting this finding and Statement of Overriding Considerations.

* * * * *

The foregoing resolution was duly and regularly introduced, passed and adopted at a regular meeting of the Board of Directors of the Bay Area Air Quality Management District on the Motion of Director WAGENKNECHT, seconded by VICE CHAIR RICE, on the 19th day of December, 2018 by the following vote of the Board:

AYES: BARRETT, BAUTERS, CHAVEZ, CUTTER, GIOIA, GROOM, HAGGERTY, HUDSON, JUE, KNISS, MANDELMAN, MILEY, MITCHOFF, RICE, RONEN, ROSS, SINKS, SPERING, WAGENKNECHT, ZANE

NOES: NONE

ABSENT: ABE-KOGA, CANEPA, KIM, SANCHEZ

ABSTAIN: NONE

David E. Hudson
Chairperson of the Board of Directors

ATTEST:

Rod Sinks
Secretary of the Board of Directors