Appendix B5

Health Effects from Criteria Air Pollutant Emissions Memorandum

MEMORANDUM

To:	Memorandum to File
From:	Jennifer Reed; Dudek
Subject:	Health Effects from Criteria Air Pollutant Emissions Associated with the Golden State Natural Resources Forest Resiliency Demonstration Project
Date:	October 15, 2024

1 Purpose and Introduction

In response to the California Supreme Court's *Sierra Club v. County of Fresno* (2018) 6 Cal. 5th 502 decision (referred to herein as the Friant Ranch decision), this memorandum addresses the potential for adverse health effects related to emissions of criteria air pollutants associated with construction and operation of the proposed Golden State Natural Resources Forest Resiliency Demonstration Project (project), based on scientific information and technological methods available at the time of this memorandum's preparation. The published Friant Ranch decision (issued on December 24, 2018) addresses the need to correlate mass emission values for criteria air pollutants to specific health consequences, and contains the following direction from the California Supreme Court: "The Environmental Impact Report (EIR) must provide an adequate analysis to inform the public how its bare numbers translate to create potential adverse impacts or it must explain what the agency *does* know and why, given existing scientific constraints, it cannot translate potential health impacts further." (Italics original.) (Sierra Club v. County of Fresno 2018.)

As discussed below, at the time of this memorandum's preparation, no expert agency, including the California Air Resources Board (CARB), or the U.S. Environmental Protection Agency (EPA), have approved a quantitative method to reliably, meaningfully and consistently translate the mass emission estimates for the criteria air pollutants resulting from a proposed project to specific health effects. In April 2019, the Sacramento Metropolitan Air Quality Management District (Sacramento Metropolitan AQMD) published an Interim Recommendation on implementing the Friant Ranch decision in the review and analysis of proposed projects under the California Environmental Quality Act (CEQA) in Sacramento County. In October 2020, the Sacramento Metropolitan AQMD published instructions for using a health effects screening tool for projects within their 5-Air-District Region, which is summarized in Section 4, below. In 2022, the Bay Area Air Quality Management District released health effects assessment for criteria air pollutants guidance to address the Friant Ranch case as part of their 2022 CEQA Guidelines, which is qualitative (Bay Area AQMD 2022). No other California air district or other expert agency/entity has published *quantitative* guidance on how to address the Friant Ranch decision for the state.

Nonetheless, following the Supreme Court's Friant Ranch decision, some EIRs where estimated criteria air pollutant emissions exceeded applicable air district thresholds have included a quantitative analysis of potential project-generated health effects using a combination of a regional photochemical grid model (PGM) and the EPA Benefits Mapping and Analysis Program (BenMAP or BenMAP–Community Edition (CE)). The publicly available health impact assessments (HIA) typically present results in terms of an increase in health incidences and/or the increase in background health incidence for various health outcomes resulting from the project's estimated increase in concentrations of ozone (O_3) and particulate matter with an aerodynamic diameter less than or equal to 2.5 microns ($PM_{2.5}$). To date, all of the HIAs that are publicly available that have been reviewed as part of this memorandum have concluded that the evaluated project's health effects associated with the estimated project-generated increase in concentrations of O_3 and $PM_{2.5}$ represent a small increase in incidences and a very small percent of the number of background incidences, indicating that these health impacts are negligible and potentially within the models' margin of error. A review of the publicly available HIAs in CEQA documents is provided in Section 4.

2 National and California Ambient Air Quality Standards

As discussed in Section 3.2, Air Quality, of the project's Environmental Impact Report (EIR), ambient air quality standards (AAQS) define clean air and are established to protect even the most sensitive individuals (CARB 2023a). An AAQS defines the maximum amount of a pollutant averaged over a specified period of time that can be present in outdoor air without harm to the public's health. The EPA and CARB are both authorized to set AAQS.

The Clean Air Act Amendments of 1970 instruct the EPA to set primary National AAQS (NAAQS) to protect public health, and secondary NAAQS to protect plants, forests, crops and materials from damage due to exposure to the following criteria air pollutants: O_3, nitrogen dioxide (NO_2), carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM_{10}), $PM_{2.5}$, and lead.

The federal Clean Air Act requires that the EPA reassess, at least every five years, whether adopted standards are adequate to protect public health based on current scientific evidence. The EPA is required to rely on the advice of an independent scientific panel, the Clean Air Scientific Advisory Committee. Reviewing the NAAQS is a lengthy undertaking and includes the following major phases: planning, integrated science assessment, risk/exposure assessment, policy assessment, and rulemaking (EPA 2023a). During the integrated science assessment, a comprehensive review, synthesis, and evaluation of the most policy-relevant science is conducted, including key science judgments that are important to inform the development of the risk and exposure assessments (EPA 2023a). Then, the risk/exposure assessment draws upon information and conclusions presented in the integrated science assessment to develop quantitative characterizations of exposures and associated risks to human health or the environment associated with recent air quality conditions and with air quality estimated to just meet the current or alternative standard(s) under consideration (EPA 2023a). Scientific review during policy assessment development, and the NAAQS review process in general, is thorough and extensive.

In 1959, California enacted legislation requiring the state Department of Public Health to establish AAQS and necessary controls for motor vehicle emissions (CARB 2023b). California's AAQS (CAAQS) were adopted in 1971 (CARB 2023b). The CAAQS are established for O_3, NO_2, CO, SO_2, PM_{10}, and $PM_{2.5}$, as well as hydrogen sulfide, vinyl chloride, sulfates, and visibility reducing particles.

Air quality standard setting in California commences with a critical review of all relevant peer reviewed scientific literature. The Office of Environmental Health Hazard Assessment (OEHHA) uses the review of health literature to develop a recommendation for the standard. The recommendation can be for no change or for a new standard. The review, including the OEHHA recommendation, is summarized in a document called the draft Initial Statement of Reasons (ISOR), which is released for comment by the public, and also for public peer review by the Air Quality Advisory Committee (AQAC). AQAC members are appointed by the President of the University of California for their expertise in the range of subjects covered in the ISOR, including health, exposure, air quality monitoring, atmospheric chemistry and physics, and effects on plants, trees, materials, and ecosystems. The Committee provides written comments on the draft ISOR. CARB staff next revises the ISOR based on comments from AQAC and the public. The revised ISOR is then released for a 45-day public comment period prior to consideration by the Board of CARB at a regularly scheduled Board hearing (CARB 2023c).

Federal law requires that all states attain the NAAQS. Failure of a state to reach attainment of the NAAQS by the target date can trigger penalties, including withholding of federal highway funds (CARB 2023b). California law similarly continues to mandate CAAQS, although attainment of the NAAQS has precedence over attainment of the CAAQS (CARB 2023b).

Of importance to this memorandum, California air districts have based their thresholds of significance for CEQA purposes on the levels that scientific and factual data demonstrate that the air basin can accommodate without affecting the attainment date for the NAAQS or CAAQS. Since an AAQS is based on maximum pollutant levels in outdoor air that would not harm the public's health, and air district thresholds pertain to attainment of the AAQS, this means that the thresholds established by air districts are also protective of human health. The particular thresholds of relevance to the project are illustrated in Table 3.2-7, Criteria Air Pollutant Thresholds of Significance by California Air District, of the EIR. Because O_3 is not emitted directly, air districts have established emissions-based thresholds for O_3 precursors—volatile organic compounds (VOCs) and oxides of nitrogen (NO_x)—which are intended to serve as a surrogate for an "O_3 significance threshold" (i.e., the potential for adverse O_3 impacts to occur).

The NAAQS and CAAQS for O_3, NO_2, CO, SO_2, PM_{10}, and $PM_{2.5}$ are presented in Table 1. Hydrogen sulfide, vinyl chloride, sulfates, and visibility reducing particles are not addressed further in this evaluation because they are not routinely associated with land use development projects subject to CEQA review and are thus not presented in Table 1.[1]

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[1] Ambient Air Quality Standards table is provided as Table 3.2-6 in the EIR Section 3.2, Air Quality.

Table 1. Ambient Air Quality Standards

		California Standards[a]	National Standards[b]	
Pollutant	**Averaging Time**	**Concentration[c]**	**Primary[c,d]**	**Secondary[c,e]**
O$_3$	1 hour	0.09 ppm (180 μg/m^3)	—	Same as primary standard[f]
	8 hours	0.070 ppm (137 μg/m^3)	0.070 ppm (137 μg/m^3)[f]	
NO$_2$[g]	1 hour	0.18 ppm (339 μg/m^3)	0.100 ppm (188 μg/m^3)	Same as primary standard
	Annual arithmetic mean	0.030 ppm (57 μg/m^3)	0.053 ppm (100 μg/m^3)	
CO	1 hour	20 ppm (23 mg/m^3)	35 ppm (40 mg/m^3)	None
	8 hours	9.0 ppm (10 mg/m^3)	9 ppm (10 mg/m^3)	
SO$_2$[h]	1 hour	0.25 ppm (655 μg/m^3)	0.075 ppm (196 μg/m^3)	—
	3 hours	—	—	0.5 ppm (1,300 μg/m^3)
	24 hours	0.04 ppm (105 μg/m^3)	0.14 ppm (for certain areas)[g]	—
	Annual	—	0.030 ppm (for certain areas)[g]	—
PM$_{10}$[i]	24 hours	50 μg/m^3	150 μg/m^3	Same as primary standard
	Annual arithmetic mean	20 μg/m^3	—	
PM$_{2.5}$[i]	24 hours	—	35 μg/m^3	Same as primary standard
	Annual arithmetic mean	12 μg/m^3	12.0 μg/m^3	15.0 μg/m^3
Lead[j,k]	30-day average	1.5 μg/m^3	—	—
	Calendar quarter	—	1.5 μg/m^3 (for certain areas)[k]	Same as primary standard
	Rolling 3-month average	—	0.15 μg/m^3	
Hydrogen sulfide	1 hour	0.03 ppm (42 μg/m^3)	—	—
Vinyl chloride[j]	24 hours	0.01 ppm (26 μg/m^3)	—	—
Sulfates	24 hours	25 μg/m^3	—	—
Visibility reducing particles	8 hours (10:00 a.m. to 6:00 p.m. PST)	Insufficient amount to produce an extinction coefficient of 0.23 per kilometer due to the number of particles when the relative humidity is less than 70%	—	—

Source: CARB 2016.

Notes: O$_3$ = ozone; ppm = parts per million by volume; μg/m^3 = micrograms per cubic meter; NO$_2$ = nitrogen dioxide; CO = carbon monoxide; mg/m^3= milligrams per cubic meter; SO$_2$ = sulfur dioxide; PM$_{10}$ = coarse particulate matter; PM$_{2.5}$ = fine particulate matter; PST = Pacific Standard Time.

[a] California standards for O_3, CO, SO_2 (1-hour and 24-hour), NO_2, suspended particulate matter (PM_{10}, $PM_{2.5}$), and visibility-reducing particles are values that are not to be exceeded. All others are not to be equaled or exceeded. CAAQS are listed in the Table of Standards in Section 70200 of Title 17 of the California Code of Regulations.

[b] National standards (other than O_3, NO_2, SO_2, particulate matter, and those based on annual averages or annual arithmetic mean) are not to be exceeded more than once per year. The O_3 standard is attained when the fourth highest 8-hour concentration measured at each site in a year, averaged over 3 years, is equal to or less than the standard. For PM_{10}, the 24-hour standard is attained when the expected number of days per calendar year with a 24-hour average concentration above 150 $\mu g/m^3$ is equal to or less than 1. For $PM_{2.5}$, the 24-hour standard is attained when 98% of the daily concentrations, averaged over 3 years, are equal to or less than the standard.

[c] Concentration expressed first in units in which it was promulgated. Equivalent units given in parentheses are based on a reference temperature of 25°C and a reference pressure of 760 torr. Most measurements of air quality are to be corrected to a reference temperature of 25°C and a reference pressure of 760 torr; ppm in this table refers to ppm by volume, or micromoles of pollutant per mole of gas.

[d] National primary standards: The levels of air quality necessary, with an adequate margin of safety, to protect the public health.

[e] National secondary standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

[f] On October 1, 2015, the national 8-hour O_3 primary and secondary standards were lowered from 0.075 to 0.070 ppm.

[g] To attain the national 1-hour standard, the 3-year average of the annual 98th percentile of the 1-hour daily maximum concentrations at each site must not exceed 100 parts per billion (ppb). Note that the national 1-hour standard is in units of ppb. California standards are in units of ppm. To directly compare the national 1-hour standard to the California standards, the units can be converted from ppb to ppm. In this case, the national standard of 100 ppb is identical to 0.100 ppm.

[h] On June 2, 2010, a new 1-hour SO_2 standard was established, and the existing 24-hour and annual primary standards were revoked. To attain the national 1-hour standard, the 3-year average of the annual 99th percentile of the 1-hour daily maximum concentrations at each site must not exceed 75 ppb. The 1971 SO_2 national standards (24-hour and annual) remain in effect until 1 year after an area is designated for the 2010 standard, except that in areas designated nonattainment of the 1971 standards, the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standards are approved.

[I] On December 14, 2012, the national annual $PM_{2.5}$ primary standard was lowered from 15 $\mu g/m^3$ to 12.0 $\mu g/m^3$. The existing national 24-hour $PM_{2.5}$ standards (primary and secondary) were retained at 35 $\mu g/m^3$, as was the annual secondary standard of 15 $\mu g/m^3$. The existing 24-hour PM_{10} standards (primary and secondary) of 150 $\mu g/m^3$ were also retained. The form of the annual primary and secondary standards is the annual mean averaged over 3 years.

[j] CARB has identified lead and vinyl chloride as toxic air contaminants with no threshold level of exposure for adverse health effects determined. These actions allow for the implementation of control measures at levels below the ambient concentrations specified for these pollutants.

[k] The national standard for lead was revised on October 15, 2008, to a rolling 3-month average. The 1978 lead standard (1.5-$\mu g/m^3$ as a quarterly average) remains in effect until 1 year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978 standard, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.

Pursuant to the 1990 Clean Air Act amendments, the EPA classifies air basins (or portions thereof) as “attainment” or “nonattainment” for each criteria air pollutant, based on whether the NAAQS have been achieved. Generally, if the recorded concentrations of a pollutant are lower than the standard, the area is classified as “attainment” for that pollutant. If an area exceeds the standard, the area is classified as “nonattainment” for that pollutant. If there is not enough data available to determine whether the standard is exceeded in an area, the area is designated as “unclassified” or “unclassifiable.” The designation of “unclassifiable/attainment” means that the area meets the standard or is expected to be meet the standard despite a lack of monitoring data. Nonattainment areas must develop plans to attain the NAAQS. Areas that achieve the standards after a nonattainment designation are redesignated as maintenance areas and must have approved maintenance plans to ensure continued attainment of the standards. The California Clean Air Act, like its federal counterpart, called for the designation of areas as “attainment” or “nonattainment,” but based on CAAQS rather than NAAQS.

Table 2 depicts the current attainment status of the counties where project activity would occur in respect to the NAAQS and CAAQS.[2]

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[2] The same discussion of the attainment designation is provided in Section 3.2 of the EIR.

Table 2. Attainment Status of Counties Where Project Activities Would Occur

County	Ozone		Nitrogen Dioxide		Carbon Monoxide		Sulfur Dioxide		PM_{10}		$PM_{2.5}$		Lead		Sulfates		Hydrogen Sulfide		Vinyl Chloride		VSP	
	CAAQS	NAAQS	CAAQS	NAAQS	CAAQS	NAAQS	CAAQS	NAAQS	CAAQS	NAAQS	CAAQS	NAAQS	CAAQS	NAAQS	CAAQS	NAAQS	CAAQS	NAAQS	CAAQS	NAAQS	CAAQS	NAAQS
Alpine	U	U/A	A	U/A	U	U/A	A	U/A	N	U	A	U/A	A	U/A	A	/	U	/	U	/	U	/
Amador	N	N	A	U/A	U	U/A	A	U/A	U	U	U	U/A	A	U/A	A	/	U	/	U	/	U	/
Butte	N	N	A	U/A	A	U/A	A	U/A	N	U	N	U/A	A	U/A	A	/	U	/	U	/	U	/
Calaveras	N	N	A	U/A	U	U/A	A	U/A	N	U	U	U/A	A	U/A	A	/	U	/	U	/	U	/
El Dorado[a]	N	N	A	U/A	U	U/A	A	U/A	N	U	U	N	A	U/A	A	/	U	/	U	/	U	/
Fresno	N	N	A	U/A	A	U/A	A	U/A	N	A	N	N	A	U/A	A	/	U	/	U	/	U	/
Lassen	A	U/A	A	U/A	U	U/A	A	U/A	U	U	A	U/A	A	U/A	A	/	U	/	U	/	U	/
Madera	N	N	A	U/A	U	U/A	A	U/A	N	A	N	N	A	U/A	A	/	U	/	U	/	U	/
Mariposa	N	N	A	U/A	U	U/A	A	U/A	U	U	U	U/A	A	U/A	A	/	U	/	U	/	U	/
Merced	N	N	A	U/A	U	U/A	A	U/A	N	A	N	N	A	U/A	A	/	U	/	U	/	U	/
Modoc	A	U/A	A	U/A	U	U/A	A	U/A	U	U	A	U/A	A	U/A	A	/	U	/	U	/	U	/
Mono	N	U/A	A	U/A	A	U/A	A	U/A	N	N	A	U/A	A	U/A	A	/	A	/	U	/	U	/
Nevada	N	N	A	U/A	U	U/A	A	U/A	N	U	U	U/A	A	U/A	A	/	U	/	U	/	U	/

Table 2. Attainment Status of Counties Where Project Activities Would Occur

County	Ozone		Nitrogen Dioxide		Carbon Monoxide		Sulfur Dioxide		PM$_{10}$		PM$_{2.5}$		Lead		Sulfates		Hydrogen Sulfide		Vinyl Chloride		VSP	
	CAAQS	NAAQS	CAAQS	NAAQS	CAAQS	NAAQS	CAAQS	NAAQS	CAAQS	NAAQS	CAAQS	NAAQS	CAAQS	NAAQS	CAAQS	NAAQS	CAAQS	NAAQS	CAAQS	NAAQS	CAAQS	NAAQS
Placer[b]	N	N	A	U/A	U	U/A	A	U/A	N	U	U	U/A	A	U/A	A	/	U	/	U	/	U	/
Plumas	U	U/A	A	U/A	A	U/A	A	U/A	N	U	U	U/A	A	U/A	A	/	U	/	U	/	U	/
Sacramento	N	N	A	U/A	A	U/A	A	U/A	N	A	A	N	A	U/A	A	/	U	/	U	/	U	/
San Joaquin[c]	N	N	A	U/A	A	U/A	A	U/A	N	A	N	N	A	U/A	A	/	U	/	U	/	U	/
Shasta	N	U/A	A	U/A	U	U/A	A	U/A	A	U	A	U/A	A	U/A	A	/	U	/	U	/	U	/
Sierra	U	U/A	A	U/A	U	U/A	A	U/A	N	U	U	U/A	A	U/A	A	/	U	/	U	/	U	/
Siskiyou	A	U/A	A	U/A	U	U/A	A	U/A	A	U	A	U/A	A	U/A	A	/	U	/	U	/	U	/
Stanislaus	N	N	A	U/A	A	U/A	A	U/A	N	A	N	N	A	U/A	A	/	U	/	U	/	U	/
Sutter	N	U/A	A	U/A	A	U/A	A	U/A	N	U	N	U/A	A	U/A	A	/	U	/	U	/	U	/
Tehama	N	U/A	A	U/A	U	U/A	A	U/A	N	U	U	U/A	A	U/A	A	/	U	/	U	/	U	/
Trinity	A	U/A	A	U/A	U	U/A	A	U/A	A	U	A	U/A	A	U/A	A	/	U	/	U	/	U	/
Tuolumne	T	N	A	U/A	A	U/A	A	U/A	U	A	U	U/A	A	U/A	A	/	U	/	U	/	U	/

Table 2. Attainment Status of Counties Where Project Activities Would Occur

County	Ozone		Nitrogen Dioxide		Carbon Monoxide		Sulfur Dioxide		PM_{10}		$PM_{2.5}$		Lead		Sulfates		Hydrogen Sulfide		Vinyl Chloride		VSP	
	CAAQS	NAAQS	CAAQS	NAAQS	CAAQS	NAAQS	CAAQS	NAAQS	CAAQS	NAAQS	CAAQS	NAAQS	CAAQS	NAAQS	CAAQS	NAAQS	CAAQS	NAAQS	CAAQS	NAAQS	CAAQS	NAAQS
Yuba	N	U/A	A	U/A	U	U/A	A	U/A	N	U	N	U/A	A	U/A	A	/	U	/	U	/	U	/

Source: EPA 2024b; CARB 2024b

Notes: N = nonattainment; A = attainment; U = unclassified; U/A = unclassified/attainment; T = nonattainment/transitional; / = no data or not applicable

[a] The eastern portion of El Dorado County (Lake Tahoe Air Basin) is in attainment for the CAAQS and NAAQS for ozone, $PM_{2.5}$, and PM_{10}; however, the western portion (Mountain Counties Air Basin) is in nonattainment for ozone and unclassified for PM_{10}. A fraction of the County located in the Mountain Counties Air Basin is also in nonattainment for the $PM_{2.5}$ NAAQS.

[b] The eastern portion of Placer County (Lake Tahoe Air Basin) is in attainment for the CAAQS and NAAQS for ozone; however, the western portion (Sacramento Valley Air Basin and Mountain Counties Air Basin) is in nonattainment for ozone. The far western portion (Sacramento Valley Air Basin) and far eastern portion (Lake Tahoe Air Basin) is in attainment the $PM_{2.5}$ CAAQS, and the middle portion (Mountain Counties Air Basin) is designated unclassified for the $PM_{2.5}$ CAAQS. The far western portion (Sacramento Valley Air Basin) is also in nonattainment for the $PM_{2.5}$ NAAQS.

[c] The western portion (San Joaquin Valley Air Basin) is in nonattainment. The San Joaquin Valley Air Basin is in attainment for the PM_{10} and $PM_{2.5}$ NAAQS.

As discussed in 3.2.2, Regulatory Setting, of the EIR, various California air districts are responsible for developing and implementing the clean air plan for attainment and maintenance of the AAQS in their associated air basin. Accordingly, these air districts have adopted federal and state attainment plans. As air districts develop and implement plans and control measures designed to attain the AAQS, the air districts implement measures to reduce public health effects associated with criteria air pollutants.

3 Health Effects of Criteria Air Pollutants and their Precursors

Numerous scientific studies published over the past 50 years point to the harmful effects of air pollution (CARB 2023b). As explained above, the AAQS are designed to prevent these effects (CARB 2023b). The adverse health effects associated with air pollution include, but are not limited to (South Coast AQMD 2022):

- Premature mortality
- Cardiovascular effects
- Cancer
- Reproductive effects
- Neurological effects
- Increased respiratory illness and other morbidity (symptoms, infections, and asthma exacerbation)

The evidence linking these effects to air pollutants is derived from population-based observational and field studies (epidemiological), toxicological studies, as well as controlled laboratory studies involving human subjects and animals. There have been an increasing number of studies focusing on the mechanisms (that is, on learning how specific organs, cell types, and biomarkers are involved in the human body's response to air pollution) and specific pollutants responsible for individual effects. Yet the underlying biological pathways for these effects are not always clearly understood (South Coast AQMD 2022).

Although individuals inhale pollutants as a mixture under ambient conditions, the regulatory framework and the control measures developed are pollutant-specific for six major outdoor pollutants covered under Sections 108 and 109 of the Clean Air Act. This is appropriate, in that different pollutants usually differ in their sources, their times and places of occurrence, the kinds of health effects they may cause, and their overall levels of health risk. Different pollutants, from the same or different sources, oftentimes occur together. Evidence for more than additive effects has not been strong and, as a practical matter, health scientists, as well as regulatory officials, usually must deal with one pollutant at a time in adopting AAQS (South Coast AQMD 2022).

Health effects associated with criteria air pollutants are discussed below; the same or similar information is provided in Section 3.2.1.1, Pollutants and Effects, of the project's EIR.

Ozone. O_3 is a strong-smelling, pale blue, reactive, toxic chemical gas consisting of three oxygen atoms. It is a secondary pollutant formed in the atmosphere by a photochemical process involving the sun's energy and O_3 precursors. These precursors are mainly NO_x and VOCs. The maximum effects of precursor emissions on O_3 concentrations usually occur several hours after they are emitted and many miles from the source. Meteorology and terrain play major roles in O_3 formation, and ideal conditions occur during summer and early autumn on days with low wind speeds or stagnant air, warm temperatures, and cloudless skies. O_3 exists in the upper atmosphere O_3 layer (stratospheric O_3) and at the Earth's surface in the troposphere (ground-level O_3).[3] The O_3 that the EPA and CARB regulate as a criteria air pollutant is produced close to the ground level, where people live, exercise, and breathe. Ground-level O_3 is a harmful air pollutant that causes numerous adverse health effects and is thus

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[3] The troposphere is the layer of the Earth's atmosphere nearest to the surface of the Earth. The troposphere extends outward about 5 miles at the poles and about 10 miles at the equator.

considered "bad" O_3. Stratospheric, or "good," O_3 occurs naturally in the upper atmosphere, where it reduces the amount of ultraviolet light (i.e., solar radiation) entering the Earth's atmosphere. Without the protection of the beneficial stratospheric O_3 layer, plant and animal life would be seriously harmed.

O_3 in the troposphere causes numerous adverse health effects; short-term exposures (lasting for a few hours) to O_3 at levels typically observed in Southern California can result in breathing pattern changes, reduction of breathing capacity, increased susceptibility to infections, inflammation of the lung tissue, and some immunological changes (EPA 2013).

Inhalation of O_3 causes inflammation and irritation of the tissues lining human airways, causing and worsening a variety of symptoms. Exposure to O_3 can reduce the volume of air that the lungs breathe in, thereby causing shortness of breath. O_3 in sufficient doses increases the permeability of lung cells, rendering them more susceptible to toxins and microorganisms. The occurrence and severity of health effects from O_3 exposure vary widely among individuals, even when the dose and the duration of exposure are the same. Research shows adults and children who spend more time outdoors participating in vigorous physical activities are at greater risk from the harmful health effects of O_3 exposure. While there are relatively few studies on the effects of O_3 on children, the available studies show that children are no more or less likely to suffer harmful effects than adults. However, there are a number of reasons why children may be more susceptible to O_3 and other pollutants. Children and teens spend nearly twice as much time outdoors and engaged in vigorous activities as adults. Children breathe more rapidly than adults and inhale more pollution per pound of their body weight than adults. Also, children are less likely than adults to notice their own symptoms and avoid harmful exposures. Further research may be able to better distinguish between health effects in children and adults. Children, adolescents, and adults who exercise or work outdoors, where O_3 concentrations are the highest, are at the greatest risk of harm from this pollutant (CARB 2022b).

A number of population groups are potentially at increased risk for O_3 exposure effects. In the ongoing review of O_3, the EPA has identified populations as having adequate evidence for increased risk from O_3 exposures include individuals with asthma, younger and older age groups, individuals with reduced intake of certain nutrients such as Vitamins C and E, and outdoor workers. There is suggestive evidence for other potential factors, such as variations in genes related to oxidative metabolism or inflammation, gender, socioeconomic status, and obesity. However further evidence is needed (South Coast AQMD 2022).

The adverse effects reported with short-term O_3 exposure are greater with increased activity because activity increases the breathing rate and the volume of air reaching the lungs, resulting in an increased amount of O_3 reaching the lungs. Children may be a particularly vulnerable population to air pollution effects because they spend more time outdoors, are generally more active, and have a higher specific ventilation relative to their body weight, compared to adults (South Coast AQMD 2022).

Volatile Organic Compounds. The primary health effects of VOCs result from the formation of O_3 and its related health effects. High levels of VOCs in the atmosphere can interfere with oxygen intake by reducing the amount of available oxygen through displacement. Carcinogenic forms of hydrocarbons, such as benzene, are considered toxic air contaminants (TACs). There are no separate health standards for VOCs as a group.

Nitrogen Dioxide. NO_2 is a brownish, highly reactive gas that is present in all urban atmospheres. The major mechanism for the formation of NO_2 in the atmosphere is the oxidation of the primary air pollutant nitric oxide (NO), which is a colorless, odorless gas. NO_x plays a major role, together with VOCs, in the atmospheric reactions that produce O_3. NO_x is formed from fuel combustion under high temperature or pressure. In addition, NO_x is an important precursor to acid rain and may affect both terrestrial and aquatic ecosystems. The two major emissions sources are transportation and stationary fuel combustion sources such as electric utility and industrial boilers. NO_2 can irritate the lungs, cause bronchitis and pneumonia, and lower resistance to respiratory infections (EPA 2016).

A large body of health science literature Indicates that exposure to NO_2 can induce adverse health effects. The strongest health evidence, and the health basis for the ambient air quality standards for NO_2, results from controlled human exposure studies that show that NO_2 exposure can intensify responses to allergens in allergic asthmatics. In addition, a number of epidemiological studies have demonstrated associations between NO_2 exposure and premature death, cardiopulmonary effects, decreased lung function growth in children, respiratory symptoms, emergency room visits for asthma, and intensified allergic responses. Infants and children are particularly at risk because they have disproportionately higher exposure to NO_2 than adults due to their greater breathing rate for their body weight and their typically greater outdoor exposure duration. Several studies have shown that long-term NO_2 exposure during childhood, the period of rapid lung growth, can lead to smaller lungs at maturity in children with higher levels of exposure compared to children with lower exposure levels. In addition, children with asthma have a greater degree of airway responsiveness compared with adult asthmatics. In adults, the greatest risk is to people who have chronic respiratory diseases, such as asthma and chronic obstructive pulmonary disease (CARB 2022c).

Carbon Monoxide. CO is a colorless, odorless gas formed by the incomplete combustion of hydrocarbon, or fossil fuels. CO is emitted almost exclusively from motor vehicles, power plants, refineries, industrial boilers, ships, aircraft, and trains. In urban areas, automobile exhaust accounts for the majority of CO emissions. CO is a nonreactive air pollutant that dissipates relatively quickly; therefore, ambient CO concentrations generally follow the spatial and temporal distributions of vehicular traffic. CO concentrations are influenced by local meteorological conditions—primarily wind speed, topography, and atmospheric stability. CO from motor vehicle exhaust can become locally concentrated when surface-based temperature inversions are combined with calm atmospheric conditions, which is a typical situation at dusk in urban areas from November to February. The highest levels of CO typically occur during the colder months of the year, when inversion conditions are more frequent.

CO is harmful because it binds to hemoglobin in the blood, reducing the ability of blood to carry oxygen. This interferes with oxygen delivery to the body's organs. The most common effects of CO exposure are fatigue, headaches, confusion and reduced mental alertness, light-headedness, and dizziness due to inadequate oxygen delivery to the brain. For people with cardiovascular disease, short-term CO exposure can further reduce their body's already compromised ability to respond to the increased oxygen demands of exercise, exertion, or stress. Inadequate oxygen delivery to the heart muscle leads to chest pain and decreased exercise tolerance. Unborn babies whose mothers experience high levels of CO exposure during pregnancy are at risk of adverse developmental effects. Unborn babies, infants, elderly people, and people with anemia or with a history of heart or respiratory disease are most likely to experience health effects with exposure to elevated levels of CO (CARB 2022d).

Sulfur Dioxide. SO_2 is a colorless, pungent gas formed primarily from incomplete combustion of sulfur-containing fossil fuels. The main sources of SO_2 are coal and oil used in power plants and industries; as such, the highest levels of SO_2 are generally found near large industrial complexes. In recent years, SO_2 concentrations have been reduced by the increasingly stringent controls placed on stationary source emissions of SO_2 and limits on the sulfur content of fuels.

Controlled human exposure and epidemiological studies show that children and adults with asthma are more likely to experience adverse responses with SO_2 exposure, compared with the non-asthmatic population. Effects at levels near the 1-hour standard are those of asthma exacerbation, including bronchoconstriction accompanied by symptoms of respiratory irritation such as wheezing, shortness of breath, and chest tightness, especially during exercise or physical activity. Also, exposure at elevated levels of SO_2 (above 1 parts per million [ppm]) results in increased incidence of pulmonary symptoms and disease, decreased pulmonary function, and increased risk of mortality. Older people and people with cardiovascular disease or chronic lung disease (such as bronchitis or emphysema) are most likely to experience these adverse effects (CARB 2022e).

SO_2 is of concern both because it is a direct respiratory irritant and because it contributes to the formation of sulfate and sulfuric acid in particulate matter (NRC 2005). People with asthma are of particular concern, both because they have increased baseline airflow resistance and because their SO_2-induced increase in airflow resistance is greater than in healthy people, and it increases with the severity of their asthma (NRC 2005). SO_2 is thought to induce airway constriction via neural reflexes involving irritant receptors in the airways (NRC 2005).

Particulate Matter. Particulate matter pollution consists of very small liquid and solid particles floating in the air, which can include smoke, soot, dust, salts, acids, and metals. Particulate matter can form when gases emitted from industries and motor vehicles undergo chemical reactions in the atmosphere. $PM_{2.5}$ and PM_{10} represent fractions of particulate matter. Coarse particulate matter (PM_{10}) consists of particulate matter that is 10 microns or less in diameter, which is about 1/7 the thickness of a human hair. Major sources of PM_{10} include crushing or grinding operations; dust stirred up by vehicles traveling on roads; wood-burning stoves and fireplaces; dust from construction, landfills, and agriculture; wildfires and brush/waste burning; industrial sources; windblown dust from open lands; and atmospheric chemical and photochemical reactions. Fine particulate matter ($PM_{2.5}$) consists of particulate matter that is 2.5 microns or less in diameter, which is roughly 1/28 the diameter of a human hair. $PM_{2.5}$ results from fuel combustion (e.g., from motor vehicles and power generation and industrial facilities), residential fireplaces, and woodstoves. In addition, $PM_{2.5}$ can be formed in the atmosphere from gases such as sulfur oxides (SO_x), NO_x, and VOCs.

$PM_{2.5}$ and PM_{10} pose a greater health risk than larger-size particles. When inhaled, these tiny particles can penetrate the human respiratory system's natural defenses and damage the respiratory tract. $PM_{2.5}$ and PM_{10} can increase the number and severity of asthma attacks, cause or aggravate bronchitis and other lung diseases, and reduce the body's ability to fight infections. Very small particles of substances such as lead, sulfates, and nitrates can cause lung damage directly or be absorbed into the bloodstream, causing damage elsewhere in the body. Additionally, these substances can transport adsorbed gases such as chlorides or ammonium into the lungs, also causing injury. Whereas PM_{10} tends to collect in the upper portion of the respiratory system, $PM_{2.5}$ is so tiny that it can penetrate deeper into the lungs and damage lung tissue. Suspended particulates also damage and discolor surfaces on which they settle and produce haze and reduce regional visibility.

Several adverse health effects have been associated with exposure to both $PM_{2.5}$ and PM_{10}. For $PM_{2.5}$, short-term exposures (up to 24-hour duration) have been associated with premature mortality, increased hospital admissions for heart or lung causes, acute and chronic bronchitis, asthma attacks, emergency room visits, respiratory symptoms, and restricted activity days. These adverse health effects have been reported primarily in infants, children, and older adults with preexisting heart or lung diseases. In addition, of all of the common air pollutants, $PM_{2.5}$ is associated with the greatest proportion of adverse health effects related to air pollution, both in the United States and worldwide based on the World Health Organization's Global Burden of Disease Project. Short-term exposures to PM_{10} have been associated primarily with worsening of respiratory diseases, including asthma and chronic obstructive pulmonary disease, leading to hospitalization and emergency department visits (CARB 2022f).

Long-term exposure (months to years) to $PM_{2.5}$ has been linked to premature death, particularly in people who have chronic heart or lung diseases, and reduced lung function growth in children. The effects of long-term exposure to PM_{10} are less clear, although several studies suggest a link between long-term PM_{10} exposure and respiratory mortality. The International Agency for Research on Cancer published a review in 2015 that concluded that particulate matter in outdoor air pollution causes lung cancer (CARB 2022f).

People with influenza, people with chronic respiratory and cardiovascular diseases, and older adults may suffer worsening illness and premature death as a result of breathing PM. People with bronchitis can expect aggravated symptoms from breathing PM. Children may experience a decline in lung function due to breathing in PM_{10} and $PM_{2.5}$ (EPA 2009).

PM encompasses a physically and chemically diverse class of ambient air pollutants of both anthropogenic and biological origin. The PM standard is the only NAAQS that does not target a specific chemical or family of chemical species (NRC 2005). The range of human health effects associated with ambient PM levels or demonstrated in laboratory studies has expanded from earlier concerns for total mortality and respiratory morbidity to include cardiac mortality and morbidity, blood vessel constriction, stroke, premature birth, low birth weight, retarded lung growth, enhancement of allergic responses, reduced resistance to infection, degenerative lesions in the brain, and lung cancer (EPA 2004).

4 Scientific and Technological Complexities, Guidance, and Methods

At issue in the Friant Ranch decision was the fact that a development project's environmental analysis did not connect its mass emission totals to specific adverse human health effects. Concerned with the sufficiency of the environmental analysis as an informational document, and specifically whether the magnitude of project impacts was adequately disclosed, the California Supreme Court stated the following:

> "The task for real party and the County is clear: The EIR must provide an adequate analysis to inform the public how its bare numbers translate to create potential adverse impacts or it must adequately explain what the agency *does* know and why, given existing scientific constraints, it cannot translate potential health impacts further." (Sierra Club v. County of Fresno 2018; italics original)

As discussed further below, at the time of this writing, no available modeling tools have been proven to provide a reliable and meaningful analysis to correlate an increase in mass totals or concentrations of criteria air pollutants from an individual project to specific health effects, or estimate additional pollutant nonattainment days relative to the NAAQS and CAAQS due to a single project.

Available guidance and expert opinion are summarized below and includes the San Joaquin Valley APCD amicus brief, the South Coast AQMD amicus brief, the Sacramento Metropolitan quantitative guidance and tools for projects within the 5-Air-District region, the Bay Area AQMD qualitative guidance, the City of Los Angeles qualitative guidance, and the Association of Environmental Professionals Climate Change Committee qualitative guidance.

Methods available are also discussed including publicly available HIAs conducted for CEQA analyses using a PGM and BenMAP, and the EPA Co-Benefits Risk Assessment (COBRA) health impacts screening and mapping tool.

Formation of Secondary Pollutants

The California Supreme Court noted, in the Friant Ranch decision, that: "The raw numbers estimating the tons per year of ROG and NO_x from the Project do not give any information to the reader about how much ozone is estimated to be produced as a result."

In response, the formation of O_3 and PM in the atmosphere, as secondary pollutants,[4] involves complex chemical and physical interactions of multiple pollutants from natural and anthropogenic sources, as further explained below. The complexity in how secondary pollutants are formed and dispersed has resulted in ongoing difficulties in measuring and regulating those pollutants.

Tropospheric, or ground level O_3, is not emitted directly into the air, but is created by chemical reactions between NO_x and VOCs (EPA 2023c). This happens when pollutants emitted by cars, power plants, industrial boilers, refineries, chemical plants, and other sources chemically react in the presence of sunlight (EPA 2023c). O_3 is most likely to reach unhealthy levels on hot sunny days in urban environments, but can still reach high levels during colder months (EPA 2023c). O_3 can also be transported long distances by wind, so even rural areas can experience high O_3 levels (EPA 2023c).

The O_3 reaction is self-perpetuating (or catalytic) in the presence of sunlight because NO_2 is photochemically reformed from NO. In this way, O_3 is controlled by both NO_x and VOC emissions (NRC 2005). The complexity of these interacting cycles of pollutants means that incremental decreases in one emission may not result in proportional decreases in O_3 (NRC 2005). Although these reactions and interactions are well understood, variability in emission source operations and meteorology creates uncertainty in the modeled O_3 concentrations to which downwind populations may be exposed (NRC 2005). This is especially true for individual projects, like the project, where project-generated criteria air pollutant emissions are not solely derived from a single "point source," but also from mobile sources (cars and trucks), trains, off-road equipment, energy consumption, and area sources (consumer products, architectural coating, etc.).

In many urban areas, O_3 nonattainment is not caused by emissions from the local area alone (EPA 2008). Due to atmospheric transport, contributions of precursors from the surrounding region can also be important (EPA 2008, O_3 NAAQS). Thus, in designing control strategies to reduce O_3 concentrations in a local area, it is often necessary to account for regional transport within the U.S. (EPA 2008). In some areas, such as California, global transport of O_3 from beyond North America also can contribute to nonattainment areas (EPA 2008).

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[4] Air pollutants formed through chemical reactions in the atmosphere are referred to as secondary pollutants.

PM can be divided into two categories: directly emitted PM and secondary PM. Secondary PM, like O_3, is formed via complex chemical reactions in the atmosphere between precursor chemicals such as SO_x and NO_x (San Joaquin Valley APCD 2015). In general, PM_{10} is composed largely of primary particles, and a much greater portion of $PM_{2.5}$ contains secondary particles (EPA 2015b). The secondary formation of $PM_{2.5}$ is dominated by a variety of chemical species or components of atmospheric particles, such as ammonium sulfate, ammonium nitrate, organic carbon mass, elemental carbon, and other soil compounds and oxidized metals. $PM_{2.5}$, sulfate, nitrate, and ammonium ions are predominantly the result of chemical reactions of the oxidized products of SO_2 and NO_x emissions with direct ammonia emission (EPA 2017). Because of the complexity of secondary PM formation, including the potential to be transported long distances by wind, the tonnage of PM-forming precursor emissions in an area does not necessarily result in an equivalent concentration of secondary PM in that area (San Joaquin Valley APCD 2015).

Because of the long-range transport of some pollutants, important emission sources may be far from the locations where measured pollutant concentrations exceed the AAQS (NRC 2005). Thus, for areas experiencing higher ambient concentrations of pollutants, such as O_3 and PM, controlling emissions of those pollutants and their precursors is typically a regional, often multistate, problem, not a local one (NRC 2005).

San Joaquin Valley Air Pollution Control District and South Coast Air Quality Management District Briefs

In connection with the judicial proceedings culminating in issuance of the Friant Ranch decision, the San Joaquin Valley Air Pollution Control District (San Joaquin Valley APCD) and the South Coast AQMD filed amicus briefs attesting to the extreme difficulty of correlating an individual project's criteria air pollutant emissions to specific health impacts. Both the San Joaquin Valley APCD and the South Coast AQMD have among the most sophisticated air quality modeling and health impact evaluation capabilities of the air districts in the State. While the information and arguments presented in those briefs was considered by the California Supreme Court, the Court noted that such information was not part of the administrative record associated with the County's decision to approve the Friant Ranch project. A summary of the key, relevant points of the San Joaquin Valley APCD and South Coast AQMD briefs is provided below.

Difference between Toxic Air Contaminants and Criteria Air Pollutants

As explained in Section 3.2.1.1, Pollutants and Effects, a TAC is an air pollutant, identified in regulation by CARB, which may cause or contribute to an increase in deaths or in serious illness, or which may pose a present or potential hazard to human health. TACs are considered under a different regulatory process (California Health and Safety Code section 39650 et seq.) than pollutants subject to CAAQS and NAAQS. Health effects to TACs may occur at extremely low levels and it is typically difficult to identify levels of exposure which do not produce adverse health effects. A criteria air pollutant, on the other hand, is an air pollutant for which acceptable levels of exposure can be determined and for which an AAQS has been set.

As the San Joaquin Valley APCD explained in their brief, "Although criteria air pollutants can also be harmful to human health, they are distinguishable from TACs and are regulated separately. The most relevant difference between criteria pollutants and TACs for purposes of this case is the manner in which human health impacts are accounted for. While it is common practice to analyze the correlation between an individual facility's TAC emissions and the expected localized human health impacts, such is not the case for criteria pollutants" (San Joaquin Valley APCD 2015). Unlike with TACs (where assessment occurs in conjunction with environmental analysis for individual projects), the human health impacts associated with criteria air pollutants are analyzed and taken into consideration when EPA sets the NAAQS for each criteria pollutant. (42 U.S.C. § 7409(b)(1).) The health impact of a particular criteria pollutant is analyzed on a regional and not a facility or individual project level based on how close the area is to complying with (attaining) the NAAQS (San Joaquin Valley APCD 2015). The San Joaquin Valley APCD concluded that while it is possible to perform a health impact analysis for TACs, which was done for construction and operation of the project as applicable to the activity areas (see Section 3.2.4 Impacts Analysis), "it is not feasible to conduct a similar analysis for criteria air pollutants because currently available computer modeling tools are not equipped for this task" (San Joaquin Valley APCD 2015).

Disconnect Between Mass and Concentration

Another important technical nuance is that health effects from air pollutants are related to the concentration of the air pollutant that an individual is exposed to, not necessarily the individual mass quantity of emissions associated with an individual project. For example, health effects from O_3 are correlated with increases in the ambient level of O_3 in the air a person breathes (South Coast AQMD 2015). However, it takes a large amount of additional precursor emissions to cause a modeled increase in ambient O_3 levels over an entire region (South Coast AQMD 2015).

For CEQA analyses, project-generated emissions are typically estimated in pounds per day or tons per year and compared to mass daily or annual emission thresholds. While CEQA thresholds are established at levels that the air basin can accommodate without affecting the attainment date for the AAQS, even if a project exceeds established CEQA significance thresholds, this does not mean that one can easily determine the concentration of O_3 or PM that will be created at or near the project site on a particular day or month of the year, or what specific health impacts will occur (San Joaquin Valley APCD 2015).

As the San Joaquin Valley APCD points out, the tonnage of PM "emitted does not always equate to the local PM concentration because it can be transported long distances by wind," and "[s]econdary PM, like O_3, is formed via complex chemical reactions in the atmosphere between precursor chemicals such as sulfur dioxides (SO_x) and NO_x," meaning that "the tonnage of PM-forming precursor emissions in an area does not necessarily result in an equivalent concentration of secondary PM in that area" (San Joaquin Valley APCD 2015). The disconnect between the tonnage of precursor pollutants (NO_x, SO_x and VOCs) and the concentration of O_3 or PM formed is important because it is not necessarily the tonnage of precursor pollutants that causes human health effects, but the concentration of resulting O_3 or PM (San Joaquin Valley APCD 2015). As discussed previously, the AAQS are established as concentrations of O_3 or PM and not as tonnages of their precursor pollutants (San Joaquin Valley APCD 2015). The disconnect between the amount of precursor pollutants and the concentration of O_3 or PM formed makes it difficult to determine potential health impacts, which are related to the concentration of O_3 and PM experienced by the receptor rather than levels of NO_x, SO_x, and VOCs produced by a source (San Joaquin Valley APCD 2015).

As discussed above, attainment of a particular AAQS occurs when the concentration of the relevant pollutant remains below a set threshold on a consistent basis throughout a particular region (San Joaquin Valley APCD 2015). Because the AAQS are focused on achieving a particular concentration of pollution region-wide, an air district's tools and plans for attaining the AAQS are regional in nature (San Joaquin Valley APCD 2015). For instance, the computer models used to simulate and predict an attainment date for the O_3 or PM NAAQS in the San Joaquin Valley are based on regional inputs, such as regional inventories of precursor pollutants (NO_x, SO_x and VOCs) and the atmospheric chemistry and meteorology of the San Joaquin Valley (San Joaquin Valley APCD 2015). At a very basic level, the models simulate future O_3 or PM levels based on predicted changes in precursor emissions San Joaquin Valley Air Basin-wide (San Joaquin Valley APCD 2015). Because the AAQS are set levels necessary to protect human health, the closer a region is to attaining a particular AAQS, the lower the human health impact is from that pollutant (San Joaquin Valley APCD 2015).

The goal of these modeling exercises is not to determine whether the emissions generated by a particular factory or development project will affect the date that the San Joaquin Valley Air Basin attains the AAQS (San Joaquin Valley APCD 2015). Rather, the San Joaquin Valley APCD's modeling and planning strategy is regional in nature and based on the extent to which all of the emission-generating sources in the San Joaquin Valley Air Basin (current and future) must be controlled in order to reach attainment (San Joaquin Valley APCD 2015).

Correlation to Health Effects

The San Joaquin Valley APCD ties the difficulty of correlating the emission of criteria pollutants to health impacts to how O_3 and PM are formed, as explained above. According to San Joaquin Valley APCD, "even once a model is developed to accurately ascertain local increases in concentrations of photochemical pollutants like O_3 and some particulates, it remains impossible, using today's models, to correlate that increase in concentration to a specific health impact [because] such models are designed to determine regional, population-wide health impacts, and simply are not accurate when applied at the local level" (San Joaquin Valley APCD 2015).

South Coast AQMD used O_3, which is formed from the chemical reaction of NO_x and VOCs in the presence of sunlight, as an example of why it is impracticable to determine specific health outcomes from criteria pollutants for all but very large, regional-scale projects. First, forming O_3 "takes time and the influence of meteorological conditions for these reactions to occur, so ozone may be formed at a distance downwind from the sources" (South Coast AQMD 2015). Second, "it takes a large amount of additional precursor emissions (NO_x and VOCs) to cause a modeled increase in ambient ozone levels over an entire region," with a 2012 study showing that "reducing NO_x by 432 tons per day (157,680 tons/year) and reducing VOC by 187 tons per day (68,255 tons/year) would reduce ozone levels at the South Coast AQMD's monitor site with the highest levels by only 9 parts per billion" (South Coast AQMD 2015). South Coast AQMD thus concludes that it "does not currently know of a way to accurately quantify O_3-related health impacts caused by NO_x or VOC emissions from relatively small projects" (South Coast AQMD 2015).

Essentially, South Coast AQMD takes the position that a project emitting only 10 tons per year of NO_x or VOC is small enough that its regional impact on ambient O_3 levels may not be detected in the regional air quality models that are currently used to determine O_3 levels; thus, in this case it would not be feasible to directly correlate project emissions of VOC or NO_x with specific health impacts from O_3 (South Coast AQMD 2015). Therefore, lead agencies that use South Coast AQMD 's thresholds of significance may determine that many projects have "significant" air quality impacts and must apply all feasible mitigation measures, yet will not be able to precisely correlate the project to quantifiable health impacts.

Effects on Number of Nonattainment Days

In regard to regional concentrations and air basin attainment, the San Joaquin Valley APCD emphasized that attempting to identify a change in background pollutant concentrations that can be attributed to a single project, even one as large as the entire Friant Ranch Specific Plan, is a theoretical exercise. The San Joaquin Valley APCD brief noted that it "would be extremely difficult to model the impact on NAAQS attainment that the emissions from the Friant Ranch project may have" (San Joaquin Valley APCD 2015). The situation is further complicated by the fact that background concentrations of regional pollutants are not uniform either temporally or geographically throughout an air basin, but are constantly fluctuating based upon meteorology and other environmental factors. As discussed above, the currently available modeling tools are equipped to model the impact of all emission sources in the San Joaquin Valley Air Basin on attainment (San Joaquin Valley APCD 2015). The San Joaquin Valley APCD brief then indicated that, "Running the photochemical grid model used for predicting O_3 attainment with the emissions solely from the Friant Ranch project (which equate to less than one-tenth of one percent of the total NO_x and VOC in the Valley) is not likely to yield valid information given the relative scale involved" (San Joaquin Valley APCD 2015).

Sacramento Metropolitan Air Quality Management District

As previously discussed, the Sacramento Metropolitan AQMD is one of two California air districts to date to formally release guidance (Interim Recommendation in April 2019 and Final Guidance in October 2020) for lead agencies and practitioners preparing CEQA documents for projects to comply with the Friant Ranch decision. The Sacramento Metropolitan AQMD *Guidance to Address the Friant Ranch Ruling for CEQA Projects in the Sac Metro Air District* fully details how projects should address the Friant Ranch ruling within the 5-Air-District Region (i.e., Sacramento Metropolitan AQMD, Yolo-Solano AQMD, Placer County APCD, El Dorado County AQMD, and Feather River AQMD) (Sacramento Metropolitan AQMD 2020a). This guidance provides insight on the health effects that may result from a project emitting at the maximum thresholds of significance (TOS) levels in the 5-Air-District Region for NO_x, VOCs, and PM, in addition to levels of CO and SO_x calculated proportional to NO_x; provides look-up tables for estimating health effects for strategic areas where growth exceeding thresholds of significance is anticipated; provides modeling guidance for CEQA projects that have emissions in excess of the significance thresholds and are located outside the strategic areas modeled; and provides information on disclosing health effects in an overall health context in a CEQA document.

In support of the formal guidance, in December 2020, the Sacramento Metropolitan AQMD released the *Minor Project Health Effects Screening Tool* and *Strategic Area Project Health Effects Screening Tool* (Sacramento Metropolitan AQMD 2020b) which were developed to estimate health effects for proposed projects within the 5-Air-District Region. For the minor project tool, the user inputs the location of the proposed project in latitude and longitude coordinates using decimal degrees and the tool assumes the maximum TOS (i.e., 82 pounds per day of ROG, NO_x, and $PM_{2.5}$). For the strategic area project health effects tool, the user inputs estimated daily ROG, NO_x, and $PM_{2.5}$ emissions up to 8 times the TOS (i.e., 656 pounds per day of ROG, NO_x, and $PM_{2.5}$) as well as the representative strategic area location. The non-screening option the Sacramento Metropolitan AQMD guidance outlines is the same or similar approach taken in the six available HIAs noted below in "Health Impact Assessments" (i.e., using a PGM and BenMAP for a specific project).

Application of the Sacramento Metropolitan AQMD screening analysis is not appropriate for the project on the whole because activities and associated emissions largely occur outside of the region evaluated in the 5-Air-District guidance and project emissions span multiple air districts. A portion of project emissions do occur within the Sacramento Metropolitan AQMD, Placer County APCD, El Dorado County AQMD, and Feather River AQMD as a result of feedstock acquisition and/or line-haul (train) travel where emissions would be dispersed (line-haul travel would be linear and not concentrated in one area) and the specific location within the air district is not identifiable at this time for feedstock activities, which would also likely not occur in one location for a prolonged period of time (e.g., under a year). Of note, the Sacramento Metropolitan AQMD tools assume a full year of continual exposure at the maximum daily emissions, which is an unreasonable assumption for the project's feedstock and line-haul activities and associated emissions. The project would also result in air quality benefits linked to avoided wildfire and associated criteria air pollutant emissions, which could not be included in the screening tools as the specific location of the anticipated benefits cannot be determined at this time.

Bay Area Air Quality Management District

In 2022, the Bay Area AQMD released "health effects assessment for criteria air pollutants" guidance to address the Friant Ranch case as part of their 2022 CEQA Guidelines. The following text is the quoted from the Bay Area AQMD guidance (Bay Area AQMD 2022):

"To comply with the Friant Ranch decision, lead agencies need to sufficiently explain the nature and magnitude of significant impacts identified by criteria air pollutant and precursor air quality analyses such that readers can meaningfully understand them. Moreover, lead agencies must make a reasonable effort to connect a project's emissions, where significant, to foreseeable health impacts or provide evidence as to why such an analysis is not scientifically possible.

To demonstrate compliance with the Friant Ranch decision, lead agencies should structure the analyses of criteria air pollutant and precursor impacts as follows:

1. Introduce and describe the potential adverse health effects related to exposure to various criteria air pollutants and precursors in exceedance of the NAAQS and CAAQS, both acutely and chronically.

2. Describe the development and use of mass emissions thresholds using substantial evidence provided in the Air District's thresholds justification report.

   > *Lead agencies must describe the rationale behind the thresholds of significance for evaluating criteria air pollutant and ozone precursor emissions (see Appendix A, Thresholds of Significance Justification). These project-level mass emissions thresholds are developed in consideration of long-term air quality planning in the SFBAAB and are designed to capture excess emissions that would inhibit attainment of the NAAQS and CAAQS for various pollutants. Projects that exceed these mass emissions thresholds, whether before mitigation or following application of mitigation measures, may contribute emissions that would degrade the ambient air quality of the SFBAAB and expose receptors to concentrations of criteria air pollutants found by EPA and CARB to be hazardous to human health. Lead agencies must make a good-faith effort to explain the connection between the thresholds of significance, long-term air quality planning, NAAQS and CAAQS, and the potential for adverse human health impacts to occur from a project's emissions contribution given that neither the NAAQS or CAAQS are not health impact thresholds below which no significant health impacts are expected.*

3. Provide a meaningful and understandable narrative of ozone and secondary PM formation.

4. Explain the approach used, including the applicability and limitations of modeling tools, to translate project emissions into health impacts or explain why it was not scientifically feasible to do so.

   > *Various modeling tools are available to estimate project-level emissions (e.g., CalEEMod). Additionally, EMFAC generates emissions estimates from transportation sources using factors that*

> *account for various state and federal regulations that affect gasoline and diesel fuel consumption, as well as the deployment of electric vehicles throughout the state. However, these models do not predict the locations of exceedances of the NAAQS or CAAQS from one project's emissions alone.*
>
> *Photochemical grid-based models simulate the chemical interactions and three-dimensional dispersion patterns on a regional, statewide, and national scale. These models are complex and require significant expertise, knowledge, and resources as they build on other third-party models and processing tools that characterize meteorology, emissions, and other environmental conditions, such as land cover, radiative properties, and boundary conditions. Use of these models is typically beyond the resources available for air quality analysis prepared pursuant to CEQA, and even if such an analysis was to be completed consideration would need be given to ensure the results would be meaningful based on modeling and data limitations.*
>
> *The Environmental Benefits Mapping and Analysis Program (BenMAP) is an open-source computer program that calculates the number and economic value of air pollution–related death and illnesses. BenMAP relies on national data such as age, health, and economic conditions, to characterize and map health impacts associated with air pollution exposure. Data applicability should be considered to determine whether the model may be appropriate for an air quality analysis prepared pursuant to CEQA and if such an analysis would provide meaningful results based on modeling and data limitations.*

5. If scientifically feasible, tie the project's emissions to potential negative health impacts if emissions would exceed mass emissions thresholds, both before and after implementing mitigation measures."

City of Los Angeles

The City of Los Angeles Department of City Planning, along with its Technical Advisory Panel of air quality consultants, prepared a guidance document on Air Quality and Health Effects to address the Friant Ranch case. The City of Los Angeles's Health Effects guidance document includes an introduction, background and methodology that discusses CEQA thresholds of significance and available models, various air quality and health effects considerations including health effects addressed in plans and regulatory standards, health effects of criteria pollutants and TACs, and relating adverse air quality impacts and health effects conclusions.

The introduction explains that, "This paper provides information to the public regarding health consequences associated with exposure to air pollutants and explains why direct correlation of a project's pollutant emissions and anticipated health effects is currently infeasible, as no expert agency has approved a quantitative method to reliably and meaningfully translate mass emission estimates of criteria air pollutants to specific health effects for the scale of projects typically analyzed in City EIRs" (City of Los Angeles 2019).

The City's guidance continues to state that, "directly correlating a single project's emissions in a typical City EIR to quantifiable human health consequences is currently not scientifically feasible, as it is not possible to conduct such an analysis that would provide reliable or meaningful results. … it is also infeasible to correlate regional emissions from local area-wide projects or plans identified in City EIRs to quantified human health consequences in any reliable or meaningful way, for many of the same reasons, and with additional challenges associated with separating and anticipating reasonably foreseeable emissions from other sources." (City of Los Angeles 2019)

Association of Environmental Professionals – Climate Change Committee

The California Association of Environmental Professionals Winter 2020 Environmental Monitor newsletter included an article titled, "We Can Model Regional Emissions, But Are the Results Meaningful for CEQA?" written by members of the AEP Climate Change Committee, which consists of air quality and climate change experts at environmental consulting firms. The article addresses the Friant Ranch case and HIAs that use PGMs and BenMAP to estimate health impacts from increases in concentrations of O_3 and $PM_{2.5}$.

The article acknowledges that it is technically feasible to conduct regional-scale criteria air pollutant modeling for an individual project, but highlights the limitations of regional-scale dispersion models such as low resolution and spatial averaging that produces "noise" and model uncertainty that can exceed a project's specific emissions, and that regional-scale models are highly contingent upon background concentrations where factors such as meteorology and topography greatly affect the certainty levels of predicted concentrations at receptor points. As a result, there are statistical ranges of uncertainty through all the modeling steps. Due to these factors, it is difficult to predict ground-level secondary PM and O_3 concentrations associated with relatively small emission sources with a high degree of certainty. (AEP 2020)

The article also highlights limitations and uncertainties of BenMAP. For example, regional models assign the same toxicity to PM regardless of the source of PM (such as road dust and exhaust), and thus potentially overpredict adverse health effects of PM. BenMAP also assumes that health effects can occur at any concentration, including small incremental concentrations, and assumes that impacts seen at large concentration differences can be linearly scaled down to small increases in concentration, with no consideration of potential thresholds below which health impacts may not occur. Additionally, BenMAP is used for assessing impacts over large areas and populations and was not intended to be used for individual projects. For health incidences, the number of hospitalizations or increase in morbidity predicted by BenMAP is greatly affected by the population characteristics. The article explains that small increases in emissions in an area with a high population have a much greater affect than large increases in emissions over an area with a small population. As a result, the same amount of emissions generated in an urban area could result in greater health consequences than if the same emissions occurred on the urban periphery, where fewer people may be affected. (AEP 2020)

The article then concludes that, "Given the margin of uncertainty at each step in the process (regional scale modeling, existing ambient air quality effects on health, population health conditions vulnerability, and marginal health effects of air pollution), the identification of marginal health effects due to individual projects using regional air quality modelling and tools such as BenMap are likely to be within the level of uncertainty and thus defined as "speculative" per CEQA" (AEP 2020).

Health Impact Assessments

At the time of writing, no specific tools have been developed for use in CEQA documents to connect criteria air pollutant emissions from an individual project to specific health effects in response to Friant Ranch outside of the Sacramento Metropolitan AQMD guidance 5-AirDistrict region. However, it has been demonstrated to be technically feasible to use existing regional models and an existing health effect modeling program to evaluate individual projects, which has been conducted for a few projects. The following CEQA documents included a quantitative HIA to address Friant Ranch:

1. California State University Dominguez Hills 2018 Campus Master Plan EIR (CSUDH MP) (Cal State University Dominguez Hills 2019)

2. World Logistics Center Revised Final EIR (WLC) (Moreno Valley 2019)

3. March Joint Powers Association K4 Warehouse and Cactus Channel Improvements EIR (March JPA K4) (March JPA 2019)

4. San Diego State University Mission Valley Campus Master Plan EIR (SDSU) (San Diego State University 2019)

5. Mineta San Jose Airport Amendment to the Airport Master Plan EIR (San Jose Airport) (City of San Jose 2019)

6. City of Inglewood Basketball and Entertainment Center Project EIR (IBEC) (City of Inglewood 2019)

The first step in all the six above listed examples included running a regional PGM, such as the Community Multiscale Air Quality (CMAQ)[5] model or the Comprehensive Air Quality Model with extensions (CAMx)[6] to estimate the increase in concentrations of O_3 and $PM_{2.5}$ as a result of project-generated emissions of criteria and precursor pollutants. Air districts use photochemical air quality models for regional air quality planning. These photochemical models are large-scale air quality models that simulate the changes of pollutant concentrations in the atmosphere using a set of mathematical equations characterizing the chemical and physical processes in the atmosphere (EPA 2023d).

After estimating the increase in concentrations of O_3 and $PM_{2.5}$, the second step in the six examples includes use of BenMAP or BenMAP-CE to estimate the resulting associated health effects. BenMAP estimates the number of health incidences resulting from changes in air pollution concentrations (EPA 2023f). The health impact function in BenMAP-CE incorporates four key sources of data: (i) modeled or monitored air quality changes, (ii) population, (iii) baseline incidence rates, and (iv) an effect estimate. While BenMAP can estimate the health effects of emissions of VOC, NO_x, CO, SO_2, and $PM_{2.5}$, O_3 and $PM_{2.5}$ were determined to have the most critical health impacts and thus, were the pollutants evaluated to determine the project's health effects in four of the six examples (i.e., WLC, CSUDH MP, March JPA K4, and San Jose Airport). The current version of BenMAP-CE only has health impact functions associated with O_3 and $PM_{2.5}$, which is why the example HIAs using BenMAP-CE only quantitatively addressed O_3 and $PM_{2.5}$ related health outcomes. As such, all example HIAs focused on O_3 and $PM_{2.5}$.

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[5] The CMAQ modeling system includes state-of-the-science capabilities for conducting urban-to-regional-to-hemispheric scale simulations of multiple air quality issues, including tropospheric O_3, fine particles, TACs, acid deposition, and visibility degradation. CMAQ brings together three kinds of models: (1) Meteorological models to represent atmospheric and weather activities, (2) Emission models to represent man-made and naturally-occurring contributions to the atmosphere, and (3) An air chemistry-transport model to predict the atmospheric fate of air pollutants under varying conditions (EPA 2023e).

[6] CAMx is a three-dimensional grid-based Eulerian air quality model designed to estimate the formation and fate of oxidant precursors, primary and secondary particulate matter concentrations, and deposition over regional and urban spatial scales (e.g., over the contiguous U.S.) (EPA 2015a).

BenMAP outputs include O_3- and PM-related health endpoints such as premature mortality, hospital admissions, and emergency room visits (City of San Jose 2019). BenMAP uses the following simplified formula to relate changes in ambient air pollution to certain health endpoints (City of San Jose 2019):

$$Health\ Effect = Air\ Quality\ Change\ \times Health\ Effect\ Estimate\ \times Exposed\ Population \\ \times Background\ Health\ Incidence$$

Population characteristics are a key variable in the BenMAP estimate of health incidences. As such, small increases in emissions in an area with a high population may have a much greater affect than large increases in emissions over an area with a small population. While location and associated population is a key factor, making the six examples specific not only to the project-generated emissions, but also to the geographic location and underlying population estimates, the findings of the six examples are provided herein for context, particularly for the conclusions.

California State University Dominguez Hills 2018 Campus Master Plan EIR For the CSUDH MP, the proposed project retains the existing campus enrollment cap of 20,000 full-time-equivalent students, while providing a framework for development of the CSUDH's campus in a forward-looking manner that accommodates growth from the current enrollment of approximately 11,000 full-time-equivalent students to the maximum enrollment of 20,000 full-time-equivalent students over a planning horizon extending to 2035. The project is located within Los Angeles County within the South Coast Air Basin. For context, the maximum daily emissions of relevant pollutants generated by the CSUDH MP were estimated to be 482.6 pounds per day of VOC, 240.1 pounds per day of NO_x, 2.7 pounds per day of SO_2, and 79.5 pounds per day of $PM_{2.5}$.

The CSUDH MP presented HIA results in terms of an increase in health incidences and the increase in background health incidence for various health outcomes referred to as endpoints. The background health incidence is the actual incidence of health effects as measured in the local population in the absence of additional emissions from the project (CSUDH 2019).

The two highest $PM_{2.5}$-related health outcomes attributed to the CSUDH MP project-related increases in ambient air concentrations included mortality (10.31 incidences per year, 0.0032% in background health incidence) and asthma-related emergency room visits (4.38 incidences per year, 0.0033% in background health incidence). The remaining health endpoints, including asthma-related hospital admissions, all cardiovascular-related hospital admissions (not including myocardial infarctions), all respiratory-related hospital admissions, and nonfatal acute myocardial infarction ranged from 0.00044 to 2.44 incidences per year (0.00047% to 0.0014% in background health incidence) (CSUDH 2019).

O_3-related health outcomes attributed to the CSDUDH project-related increases in ambient air concentrations included respiratory-related hospital admissions (0.67 incidences per year, 0.00034% in background health incidence), mortality (0.28 incidences per year, 0.00013% in background health incidence), and asthma-related emergency room visits for any age range (lower than 3.38 incidences per year for all age groups, lower than 0.0058% percent in background health incidence for all age groups) (CSUDH 2019).

The CSUDH MP HIA then concluded that "for all these health endpoints, the number of estimated incidences is less than 0.0058% of the background health incidence. … When taken into context, the small increase in incidences and the very small percent of the number of background incidences indicate that these health impacts are negligible in a developed, urban environment" (CSUDH 2019).

World Logistics Center Revised Final EIR

The WLC is located within Moreno Valley within Riverside County and the South Coast Air Basin. The WLC assessed the construction and operation of 40,600,00 square feet of logistics facilities and associated infrastructure on 2,610 acres in the Rancho Belago area at the eastern end of Moreno Valley. For context, the maximum daily emissions of relevant pollutants generated by the WLC during combined construction and operations (unmitigated) were estimated to be 603 pounds per day of VOC, 1,818 pounds per day of NO_x, 10.07 pounds per day of SO_2, 1,150 pounds per day of CO, and 137 pounds per day of $PM_{2.5}$. With mitigation, the combined WLC construction and operations were estimated to generate 495 pounds per day of VOC, 1,459 pounds per day of NO_x, 10.07 pounds per day of SO_2, 1,238 pounds per day of CO, and 133 pounds per day of $PM_{2.5}$.

The two highest $PM_{2.5}$-related health outcomes attributed to the WLC project-related increases in ambient air concentrations from unmitigated emissions included mortality (15.19 incidences per year, 0.0047% in background health incidence) and asthma-related emergency room visits (6.63 incidences per year, 0.0051% in background health incidence). The remaining health endpoints, including asthma-related hospital admissions, all cardiovascular-related hospital admissions (not including myocardial infarctions), all respiratory-related hospital admissions, and nonfatal acute myocardial infarction ranged from 0.52 to 3.17 incidences per year (0.00063% to 0.0029% in background health incidence) (Moreno Valley 2019).

O_3-related health outcomes attributed to the WLC project-related increases in ambient air concentrations from unmitigated emissions included respiratory-related hospital admissions (1.46 incidences per year, 0.00075% in background health incidence), mortality (0.69 incidences per year, 0.00033% in background health incidence), and asthma-related emergency room visits for any age range (lower than 8.20 incidences per year for all age groups, lower than 0.014% percent in background health incidence for all age groups) (Moreno Valley 2019).

The WLC HIA then concluded that "when taken into context, the small increase in incidences and the very small percent of the number of background incidences indicate that these health impacts are minimal in a developed, urban environment" (Moreno Valley 2019).

March Joint Powers Association K4 Warehouse and Cactus Channel Improvements EIR

The March JPA K4 project is located within Riverside County within the South Coast Air Basin. The proposed project involves the development of the five parcels on the 35.4-acre K4 Parcel with a 718,000-square-foot building conservatively assumed to be occupied by High-Cube ecommerce/fulfillment center use. The mitigated maximum daily operational emissions of relevant pollutants generated by the March JPA K4 were estimated to be 41.0 pounds per day of VOC, 253.0 pounds per day of NO_x, 1.4 pounds per day of SO_x, and 30.3 pounds per day of $PM_{2.5}$. The March JPA K4 HIA determined that, "for all these health endpoints, the number of estimated incidences is less than 0.0042% of the baseline number of incidences," and that "these health impacts are conservatively estimated, and the actual impacts may be zero" (March JPA 2019).

San Diego State University Mission Valley Campus Master Plan EIR

The SDSU project is located within the City of San Diego within the San Diego Air Basin. The SDSU project proposes construction and operation of the SDSU Mission Valley campus, stadium, parks, recreation, and innovation area to accommodate up to 15,000 full-time-equivalent students over time, resulting in a total student headcount of approximately 20,000 students. The maximum daily emissions of relevant pollutants generated by SDSU were estimated to be 314.1 pounds per day of VOC, 1,120.7 pounds per day of NO_x, 6.5 pounds per day of SO_2, and 205.9 pounds per day of $PM_{2.5}$ (SDSU 2019).

The $PM_{2.5}$-related health outcomes attributed to the SDSU project-related increases in ambient air concentrations included mortality (8.97 incidences per year, 0.0026% in background health incidence) and asthma-related emergency room visits (5.29 incidences per year, 0.0040% in background health incidence). The remaining health endpoints, including asthma-related hospital admissions, all cardiovascular-related hospital admissions (not including myocardial infarctions), all respiratory-related hospital admissions, and nonfatal acute myocardial infarction ranged from 0.00083 to 3.33 incidences per year (0.00223% to 0.00164% in background health incidence) (SDSU 2019).

O_3-related health outcomes attributed to the SDSU project-related increases in ambient air concentrations included respiratory-related hospital admissions (0.45 incidences per year, 0.0002% in background health incidence), mortality (0.21 incidences per year, 0.00010% in background health incidence), asthma-related emergency room visits for age groups 0-17 (1.73 incidences per year, 0.003% percent in background health incidence), and asthma-related emergency room visits for age groups 18-99 (2.02 incidences per year, 0.002% percent in background health incidence) (SDSU 2019).

The SDSU HIA found that “health effects estimation using the log-linear method presumes that effects seen at large concentration differences can be linearly scaled down to small increases in concentration, with no consideration of potential thresholds below which health effects may occur; thus, this potentially overstates the potential effects. In summary, health effects are conservatively estimated, and the actual effects may be zero” (SDSU 2019).

Mineta San Jose Airport Amendment to the Airport Master Plan EIR

The San Jose Airport is located in Santa Clara County within the San Francisco Bay Area Air Basin. The San Jose Airport project includes amending the approved 2018 Airport Master Plan to a) shift the planning horizon year from 2027 to 2037, b) modifying future facility requirements at the airport to reflect updated demand forecasts, and c) modifying certain components of the airfield to reduce to potential for runway incursions (City of San Jose 2019). The estimated maximum daily incremental operational emissions of relevant pollutants generated by the San Jose Airport project were estimated to be -49.4 pounds per day of VOC, 5,325 pounds per day of NO_x, and 52 pounds per day of $PM_{2.5}$. However, the following emissions inventory was assumed for the HIA: 57.3 pounds per day of VOC, 5,643.0 pounds per day of NO_x, and 51.6 pounds per day of $PM_{2.5}$.

The San Jose Airport HIA estimated that the highest health endpoint from $PM_{2.5}$ was mortality at 4.46 incidences (0.0017% percent in background health incidence). All other $PM_{2\text{-}5}$-related health incidences ranged from 0.00022 to 1.89 (0.00027% to 0.0016% percent in background health incidence). For O_3-related health endpoints, the highest was emergency room visits for asthma, which was estimated to be 11.05 incidences (0.028% percent in background health incidence) for ages 0-17 and 14.59 incidences (0.019% percent in background health incidence) for ages 18-99 (City of San Jose 2019). Of the six examples discussed herein, the San Jose Airport resulted in the greatest O_3 incidences, which correlates with the estimated high emissions of O_3-precursors, specifically NO_x at 5,643 pounds per day. Nonetheless, the conclusion was that “when taken into context, the small increase in incidences and the very small percent of the number of background incidences indicate that these health impacts are negligible in a developed, urban environment” (City of San Jose 2019).

City of Inglewood Basketball and Entertainment Center Project EIR

The IBEC project HIA provides another important data point for consideration. The IBEC project consists of an arena designed to host the LA Clippers basketball team with up to 18,000 fixed seals for National Basketball Association games and up to 500 additional temporary seats for events such as family shows, concerts, conventions, corporate events, and non-LA Clippers sporting events. The IBEC project is located within Los Angeles County within the South Coast Air Basin. The IBEC EIR evaluated nine operational scenarios; across these multiple scenarios, the estimated maximum daily net increase in operational emissions of relevant pollutants was 94 pounds per day of VOC, 99 pounds per day of NO_x, 3 pounds per day of SO_x, and 89 pounds per day of $PM_{2.5}$.

The IBEC EIR analysis provided helpful context on using regional models for individual projects, as follows: "Generally, models that correlate criteria air pollutant concentrations with specific health effects focus on regulatory decision-making that will apply throughout an entire air basin or region. These models focus on the region-wide health effects of pollutants so that regulators can assess the costs and benefits of adopting a proposed regulation that applies to an entire category of air pollutant sources, rather than the health effects related to emissions from a specific proposed project or source. Because of the scale of these analyses, any one project is likely to have only very small incremental effects which may be difficult to differentiate from the effects of air pollutant concentrations in an entire air basin. … For regional pollutants, it is difficult to trace a particular project's criteria air pollutant emissions to a specific health effect. Moreover, the modeled results may be misleading because the margin of error in such modeling is large enough that, even if the modeled results report a given health effect, the model is sufficiently imprecise that the actual effect may differ from the reported results; that is, the modeled results suggest precision, when in fact available models cannot be that precise on a project level" (City of Inglewood 2019).

For O_3-related health endpoints, emergency room visits for asthma was estimated to be 0.087 incidence per year for all studied age groups combined, 0.016 incidence per year of respiratory-related hospital admissions, and less than 0.02 incidence per year of mortality; the amount of estimated incremental health effects incidence is less than 0.0001% of the baseline number of health effects incidences in the study area.

A key finding from the IBEC HIA was that for $PM_{2.5}$-related health endpoints, due to the very small changes in ambient $PM_{2.5}$ concentrations as modeled by CMAQ, all of the estimated incremental health incidences were negative values. The IBEC HIA stated that this further confirms that the modeled $PM_{2.5}$ concentrations are within the model's margin of error, no meaningful conclusions can be reached on the specific health effects that may be caused by the proposed project O_3 precursor and $PM_{2.5}$ emissions, and health impacts may in fact be zero, and they would still be well within the models' margin of error (City of Inglewood 2019).

Summary

It is also important to note that while these results conclude that the project emissions do not result in a substantial increase in health incidences, the estimated emissions and assumed toxicity is also conservatively inputted into the HIA and thus, overestimate health incidences, particularly for $PM_{2.5}$. For example, as discussed in the San Jose Airport HIA, "the USEPA has also stated that results from various studies have shown the importance of considering particle size, composition, and particle source in determining the health impacts of PM. Further, USEPA found that studies have reported that particles from industrial sources and from coal combustion appear to be the most significant contributors to PM-related mortality, consistent with the findings by Rohr and Wyzga and others. This is particularly important to note here, as the majority of PM emissions generated from the project are from entrained roadway dust, and not from combustion. Therefore, by not considering the relative toxicity of PM components, the results presented here are conservative" (City of San Jose 2019).

As explained in the San Joaquin Valley APCD brief and noted previously, running the PGM used for predicting O_3 attainment with the emissions solely from an individual project like the Friant Ranch project or the project is not likely to yield valid information given the relative scale involved. The six examples discussed herein support the San Joaquin Valley APCD's brief contention that consistent, reliable, and meaningful results may not be provided by methods applied at this time. Accordingly, additional work in the industry and more importantly, air district participation, is needed to develop a more meaningful analysis to correlate project-level mass criteria air pollutant emissions and health effects for decision makers and the public. Furthermore, at the time of writing, none of the HIAs that were reviewed has concluded that health effects estimated using the PGM and BenMAP approach are substantial provided that the estimated project-generated incidences represent a very small percent of the number of background incidences, potentially within the models' margin of error.

Co-Benefits Risk Assessment Health Impacts Screening and Mapping Tool

The U.S. EPA's COBRA health impacts screening and mapping tool can explore how changes in air pollution, specifically $PM_{2.5}$ and O_3, from a policy, program, or other action can affect human health at the county, state, regional, or national levels. COBRA also estimates the economic value of the health benefits associated with changes in air pollution. COBRA can map and visually represent the air quality, human health, and health-related economic impacts from emissions of $PM_{2.5}$, SO_2, NO_X, NH_3, and VOCs that result from an action. Built into COBRA are emissions inventories, a simplified air quality model, health impact equations, and economic valuations ready for use, based on assumptions that the U.S. EPA currently uses as reasonable best estimates (EPA 2024a).

COBRA estimates changes in total annual ambient concentrations of $PM_{2.5}$, including primary $PM_{2.5}$ emissions and the formation of secondary $PM_{2.5}$ from precursor pollutants, such as SO_2, NO_x, NH_3, and VOCs. With the release of version 5.0 in 2024, COBRA now also estimates the impacts of changes in O_3 formation as a result of changes in pollutants assessed by the model, specifically NO_x and VOCs. COBRA uses a series of health impact functions, taken from the peer-reviewed epidemiological literature, to estimate how changes in outdoor air quality result in changes in the incidence of a variety of health outcomes (e.g., premature mortality, heart attacks, asthma exacerbation, lost workdays). Incidence refers to the number of new cases of a health outcome over a specified time period. Finally, COBRA multiplies the change in incidence for each health outcome by a monetary value specific to that outcome. COBRA outputs the Health Effects and Valuation Results which includes a table of nationwide results as COBRA calculates health benefits in all counties in the contiguous United States due to the transport of outdoor air pollutants between counties and states. Accordingly, results are available for a particular state or county and are also provided in map form. Both the table and the map provide county-level changes in air quality (e.g., total annual average $PM_{2.5}$ concentration in $\mu g/m^3$), incidence of each health endpoint, and associated economic values. COBRA provides estimates on changes in mortality, infant mortality, nonfatal heart attacks, respiratory hospital admissions, cardiovascular hospital admissions, acute bronchitis, emergency room visits, work loss days, and asthma exacerbation. (EPA 2024a)

The change in incidence is not necessarily a whole number because COBRA calculates small statistical risk reductions that are then aggregated over the entire population. Estimates of health impacts have a direct relationship with population density: areas with higher population density tend to see higher health benefits of reduced emissions than less dense areas (EPA 2024a). This is because there are more people breathing cleaner air in the areas with higher population density. The reverse would also be true where areas with higher population density tend to see higher adverse health consequences of increased emissions compared to less dense areas.

COBRA contains detailed emission estimates of $PM_{2.5}$, SO_2, NO_X, and VOCs for the year 2016, and detailed projections for 2023 and 2028 as developed by the U.S. EPA. Users create their own scenario by specifying increases or decreases to one of the three baseline emission estimates - 2016, 2023, or 2028 (EPA 2024a). These baselines account for federal and state regulations as of May 2018.

EPA states that those who should use COBRA includes but is not limited to "analysts looking to improve their understanding of the air, health, and related economic benefits of clean energy or other policies that reduce emissions" and "environmental agencies interested in reviewing many options to identify policies that maximize health and economic benefits" (EPA 2024b). COBRA was originally developed by Abt Associates Inc. in 2002 and updated in 2012, 2017, 2020, 2021, and 2024 (EPA 2024a). COBRA is based on rigorous methods used by EPA health benefits assessments and adapted for use as a screening model.

Based on the EPA records of COBRA citations, it was used by at least approximately 150 publications as of April 24, 2024. Many of the publications evaluated programs, policies, or large areas of potential effect such as statewide efforts. The only environmental analysis was an Environmental Impact Statement for New York State's procurement of offshore wind energy; no CEQA analyses were cited (EPA 2024c). This publication list supports EPA's statement that COBRA is a valid modeling tool for state and local governments to (1) better understand the potential for clean energy to enhance air quality, health, and well-being, (2) design or select program options that maximize benefits, (3) build support for clean energy investments based on the air quality and health benefits, (4) narrow a list of policy options to those that should be evaluated using more sophisticated air quality models, (5) present information about localized health benefits in easy–to–interpret tables and maps, and (6) support a balanced decision-making process that considers both the potential costs and benefits of policy options (EPA 2024d). However, this publication list also supports that COBRA is better fit for broad analyses, such as policies and programs undertaken by state governments, rather than a CEQA analysis for an individual project.

In EPA's COBRA Questions and Answers, it addresses the question of "what is the difference between COBRA and BenMAP?" (BenMAP described in the above sections) and states that, "The key difference between BenMAP and COBRA is that COBRA has a built-in, reduced-form air quality model, while BenMAP does not. To convert changes in air pollution to changes in air quality, a tool will need an air quality model. Because BenMAP does not have this built-in model, it requires inputs of the changes in air quality rather than emissions. BenMAP users can utilize standalone air quality models, such as the Community Multi-scale Air Quality Model (CMAQ), to determine air quality changes. Additionally, BenMAP can be used to analyze health impacts at a finer geographic resolution than COBRA, depending on the scale of the air quality data that users provide. BenMAP also includes preloaded population and baseline health incidence data forecasts for all years out to 2050. COBRA only analyzes health impacts at the county-level and baseline health incidence data for 2016, 2023, and 2028. However, the desktop edition of COBRA also has advanced features that allow the user to import inputs for other years. Apart from these differences, COBRA and BenMAP both use the same approach to estimating health impacts, and both tools use the same default concentration-response functions and economic valuation functions for their calculations." (EPA 2024e)

5 Evaluation of the Project's Health Effects

Based on the evaluation of methods available provided in Section 4, this evaluation does not attempt to quantify health effects, but builds upon the discussion provided in Sections 2 and 3 to disclose potential health effects associated with the project. As explained in Section 2, the EPA and CARB have established AAQS at levels above which concentrations could be harmful to human health and welfare, with an adequate margin of safety. Further, California air districts have established emission-based thresholds that provide project-level estimates of criteria air pollutant quantities that air basins can accommodate without affecting the attainment dates for the AAQS. Accordingly, elevated levels of criteria air pollutants as a result of a project's emissions could cause adverse health effects associated with these pollutants.

Construction of the Lassen Facility would result in emissions that would not exceed the Lassen County APCD daily BACT thresholds for criteria air pollutants after implementation of Mitigation Measure (MM)-AQ-5 (Construction Equipment Exhaust Minimization – Tier 4 Final – Lassen Facility) and MM-AQ-6 (Construction Lower-VOC Paints – Lassen Facility). Construction of the Tuolumne Facility and the Port of Stockton would result in emissions that would not exceed their respective Tuolumne County APCD and San Joaquin Valley APCD thresholds for criteria air pollutants without mitigation.

Operation of the project, including feedstock acquisition, wood pellet production, and transport to market, however, would result in exceedances of regional thresholds for emissions of VOCs, NO_x, CO, PM_{10}, and $PM_{2.5}$, even after implementation of mitigation.

As discussed in above, health effects associated with O_3 include respiratory symptoms, worsening of lung disease leading to premature death, and damage to lung tissue. VOCs and NO_x are precursors to O_3 and the contribution of VOCs and NO_x to regional ambient O_3 concentrations is the result of complex photochemistry. The increases in O_3 concentrations due to O_3 precursor emissions tend to be found downwind of the source location because of the time required for the photochemical reactions to occur. Further, the potential for exacerbating excessive O_3 concentrations would also depend on the time of year that the VOC emissions would occur, because exceedances of the O_3 NAAQS and CAAQS tend to occur between April and October when solar radiation is highest. As described above, due to the lack of quantitative methods to assess this complex photochemistry, the holistic effect of a single project's emissions of O_3 precursors is speculative.

That being said, as shown in Table 3, because the project would exceed the VOC thresholds in the Lassen County APCD and NO_x thresholds in the Bay Area AQMD, Butte County AQMD, Calaveras County APCD, El Dorado County AQMJD, Feather River AQMD, Lassen County APCD, Northern Sierra AQMD, Placer County APCD, Sacramento Metropolitan AQMD, San Joaquin Valley APCD, Shasta County AQMD, and Tehama County APCD. However, for those counties designated as attainment or unclassified/unclassifiable areas for O_3 (i.e., Lassen County APCD) project-generated VOC and/or NO_x emissions may not cause an exceedance of the NAAQS and CAAQS for O_3 or result in potential health effects associated with O_3. For the air districts designated as nonattainment areas for O_3 (i.e., Bay Area AQMD, Butte County AQMD, Calaveras County APCD, El Dorado County AQMD, Feather River AQMD, Northern Sierra AQMD, Placer County APCD, Sacramento Metropolitan AQMD, San Joaquin Valley APCD, Shasta County AQMD, and Tehama County APCD), project-generated VOC and/or NO_x emissions may contribute to health effects associated with O_3.

Health effects associated with NO_x and NO_2 (which is a constituent of NO_x) include lung irritation and enhanced allergic responses. As shown in Table 3, project-related NO_x emissions would exceed the applicable NO_x thresholds in Bay Area AQMD, Butte County AQMD, Calaveras County APCD, El Dorado County AQMJD, Feather River AQMD, Lassen County APCD, Northern Sierra AQMD, Placer County APCD, Sacramento Metropolitan AQMD, San Joaquin Valley APCD, Shasta County AQMD, and Tehama County APCD. However, all those air districts are designated as attainment areas for NO_2 (and NO_2 is a constituent of NO_x). Accordingly, project-generated NOx emissions may not cause an exceedance of the NAAQS and CAAQS for NO_2 or result in potential health effects associated with NO_2 and NO_x.

Health effects associated with CO include chest pain in patients with heart disease, headache, light-headedness, and reduced mental alertness. CO tends to be a localized impact associated with congested intersections. The potential for CO hotspots is discussed under Impact AQ-3 in Chapter 3.2 of the EIR and determined to be less than significant. Thus, the project's CO emissions would not contribute to significant health effects associated with CO.

Health effects associated with PM_{10} and $PM_{2.5}$ include premature death and hospitalization, primarily for worsening of respiratory disease. As shown in Table 3, project-related PM_{10} emissions would exceed the applicable PM_{10} thresholds in Butte County AQMD, Calaveras County APCD, Feather River AQMD, Lassen County APCD, Northern Sierra AQMD, Placer County APCD, Sacramento Metropolitan AQMD, Shasta County AQMD, and Tehama County APCD. However, for those counties designated as attainment or unclassified/unclassifiable areas for PM_{10} (i.e., Lassen County APCD and Shasta County AQMD) and $PM_{2.5}$ (i.e., Calaveras County APCD, Lassen County APCD, Northern Sierra AQMD, Placer County AQMD, Sacramento Metropolitan AQMD, Shasta County AQMD, and Tehama County APCD), project-generated PM_{10} and/or $PM_{2.5}$ emissions may not cause an exceedance of the NAAQS and CAAQS for or result in potential health effects associated with PM_{10} or $PM_{2.5}$. For the air districts designated as nonattainment areas for PM_{10} (i.e., Butte County AQMD, Calaveras County APCD, Feather River AQMD, Northern Sierra AQMD, Placer County APCD, Sacramento Metropolitan AQMD, and Tehama County APCD) and or $PM_{2.5}$ (i.e., Butte County AQMD and Feather River AQMD), project-generated PM_{10} and/or $PM_{2.5}$ emissions may contribute to health effects associated with PM_{10} or $PM_{2.5}$.

Table 3 shows operational air district threshold exceedances and/or federal or California AAQS exceedances for multiple air districts. With the exception of Lassen County APCD, Tuolumne County APCD, and the San Joaquin Valley APCD, emissions would be a result of feedstock acquisition, rail transport, and ship transport. It is likely that during feedstock acquisition, the project would have multiple crews operating in different air districts on a given day. However, for purposes of comparing emissions to the most stringent daily or annual threshold, it was conservatively assumed that all crews would be operating in the same air district 100% of the time, which is unlikely.

Table 3. Health Effects of Criteria Air Pollutants – Criteria Air Pollutant Threshold Exceedances with Mitigation

	VOC	NO_x	CO	SO_x	PM_{10}	$PM_{2.5}$
Scenario	Mass Daily or Annual Threshold Exceeded with Mitigation and/or AAQS Exceedance with Mitigation?					
Bay Area AQMD	No	**Yes**	No	No	No	No
Butte County AQMD	No	**Yes**	N/A	N/A	**Yes**	**Yes**
Calaveras County APCD	No	**Yes**	N/A	N/A	**Yes**	N/A
El Dorado County AQMD	No	**Yes**	N/A	N/A	N/A	N/A
Feather River AQMD	No	**Yes**	N/A	N/A	**Yes**	N/A
Lassen County APCD	**Yes**	**Yes**	**Yes**	No	**Yes**	**Yes**
Mariposa County APCD	No	No	No	No	No	No
Northern Sierra AQMD	No	**Yes**	N/A	N/A	**Yes**	N/A
Placer County APCD	No	**Yes**	N/A	N/A	**Yes**	N/A

Table 3. Health Effects of Criteria Air Pollutants – Criteria Air Pollutant Threshold Exceedances with Mitigation

Scenario	VOC	NO_x	CO	SO_x	PM_{10}	$PM_{2.5}$
	Mass Daily or Annual Threshold Exceeded with Mitigation and/or AAQS Exceedance with Mitigation?					
Sacramento Metropolitan AQMD	No	**Yes**	N/A	N/A	**Yes**	No
San Joaquin Valley APCD	No	**Yes**	No	No	**Yes**	**Yes**
Shasta County AQMD	No	**Yes**	N/A	N/A	**Yes**	N/A
Tehama County APCD	No	**Yes**	N/A	N/A	**Yes**	N/A
Tuolumne County APCD	No	**Yes**	**Yes**	N/A	**Yes**	N/A

Notes: VOC = volatile organic compound; NO_x = oxides of nitrogen; CO = carbon monoxide; SO_x = sulfur oxides; PM_{10} = coarse particulate matter; $PM_{2.5}$ = fine particulate matter; N/A = not applicable; APCD = Air Pollution Control District; AQMD = Air Quality Management District.
This table only shows the operational impacts of the project. Construction impacts were described above.

While the above scientific and technological constraints present considerable doubt that quantifying health effects for individual CEQA projects may not accurately and meaningfully inform the public of how project-generated bare numbers (i.e., estimated criteria air pollutant emissions) translate to create potential adverse health effects, due to the size and scale of the project, additional analysis is presented below for emissions occurring within Lassen County, Tuolumne County, and San Joaquin County, where the two pellet facilities and the Port of Stockton are located, respectively, as well as for all project emissions within the State.

Co-Benefits Risk Assessment Health Impacts Screening and Mapping Tool Results

To estimate the potential health effects of the project, the US EPA's COBRA screening model was used to estimate how changes in air pollution from the project can affect human health at the county, state, regional, or national levels (EPA 2021). (COBRA is explained in detail above). The analysis year of 2028 was selected in COBRA as it is closest to the operational year in the project. The state of California and each respective county (Lassen, Tuolumne, and San Joaquin) was selected for the location. To support this CEQA evaluation, the national level change in incidents rate was not included. The emissions estimated using the methodologies in Section 3.2 of the EIR were assumed for each location. A discount rate of 2% was selected as it is the default. COBRA assumes changes in adult mortality and non-fatal heart attacks occur over a 20-year period.

For Lassen County,[7] O_3 and $PM_{2.5}$ related health outcomes attributed to project-related increases in ambient air concentrations included asthma-related emergency room visits (<0.004 incidences per year), lung cancer incidence (<0.004 incidences per year), all cardiovascular-related hospital admissions (not including myocardial infarctions) (<0.004 incidences per year), all respiratory-related hospital admissions (<0.004 incidences per year), mortality (0.05 incidences per year), and nonfatal acute myocardial infarction (less than <0.004 incidences per year for all age groups). For context, between 2020-2022, the CDPH reported that Lassen County had an annual average of 328.3 mortalities from all causes and an age-adjusted death rate of 886.8 mortalities per 100,000 population (CDPH 2024).

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[7] The COBRA inputs for mitigated annual criteria air pollutant emissions within Lassen County include the following: 194.58 tons per year VOC, 158.46 tons per year NO_x, 0.32 tons per year SO_2, and 140.71 tons per year $PM_{2.5}$.

For Tuolumne County,[8] O_3 and $PM_{2.5}$ related health outcomes attributed to project-related increases in ambient air concentrations included asthma-related emergency room visits (<0.004 incidences per year), lung cancer incidence (<0.004 incidences per year), all cardiovascular-related hospital admissions (not including myocardial infarctions) (<0.004 incidences per year), all respiratory-related hospital admissions (<0.004 incidences per year), mortality (0.07 incidences per year), and nonfatal acute myocardial infarction (less than 0.01 incidences per year for all age groups). For context, between 2020-2022, the CDPH reported that Tuolumne County had an annual average of 807 mortalities from all causes and an age-adjusted death rate of 872.2 mortalities per 100,000 population (CDPH 2024).

For San Joaquin County,[9] O_3 and $PM_{2.5}$ related health outcomes attributed to project-related increases in ambient air concentrations included asthma-related emergency room visits (<0.004 incidences per year), lung cancer incidence (<0.004 incidences per year), all cardiovascular-related hospital admissions (not including myocardial infarctions) (<0.004 incidences per year), all respiratory-related hospital admissions (0.01 incidences per year), mortality (0.10 incidences per year), and nonfatal acute myocardial infarction (less than 0.02 incidences per year for all age groups). For context, between 2020-2022, the CDPH reported that San Joaquin County had an annual average of 6,890 mortalities from all causes and an age-adjusted death rate of 870.7 mortalities per 100,000 population (CDPH 2024).

For the statewide COBRA analysis, the Table 4 presents the total criteria air pollutant emissions associated with the operation of project in tons per year with incorporation of mitigation.

Table 4. Total Project Operational Criteria Air Pollutants - Mitigated

	VOC	NO_x	CO	SO_x	PM_{10}	$PM_{2.5}$
Scenario	Tons per Year					
Lassen Feedstock	2.61	53.46	82.56	0.24	146.9	26.86
Tuolumne Feedstock	1.02	26.27	37.4	0.1	40.34	7.05
Lassen Facility Operations	193.8	133.03	238.19	0.25	140.72	139.57
Tuolumne Facility Operations	86.06	63.55	121.18	0.06	67.6	67.04
Port of Stockton Operations	0.36	0.8	1.14	0.01	0.97	0.94
Line Haul Rail Transport	2.61	61.67	14.91	0.06	1.41	1.3
Ship Transport	1.71	31.51	3.85	1.24	0.65	0.55
Total	**288.17**	**370.29**	**499.23**	**1.96**	**398.59**	**243.31**

Notes: VOC = volatile organic compound; NO_x = oxides of nitrogen; CO = carbon monoxide; SO_x = sulfur oxides; PM_{10} = coarse particulate matter; $PM_{2.5}$ = fine particulate matter.

On a statewide level,[10] O_3 and $PM_{2.5}$ related health outcomes attributed to project-related increases in ambient air concentrations included asthma-related emergency room visits (0.03 incidences per year), lung cancer incidence

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The COBRA inputs for mitigated annual criteria air pollutant emissions within Tuolumne County include the following: 86.16 tons per year VOC, 69.37 tons per year NO_x, 0.09 tons per year SO_2, and 67.45 tons per year $PM_{2.5}$.

[9] The COBRA inputs for mitigated annual criteria air pollutant emissions within San Joaquin County include the following: 1.4 per year VOC, 24.36 tons per year NO_x, 0.69 tons per year SO_2, and 1.41 tons per year $PM_{2.5}$.

[10] The COBRA inputs for mitigated annual criteria air pollutant emissions within San Joaquin County include the following: 288.17 per year VOC, 370.29 tons per year NO_x, 1.96 tons per year SO_2, and 243.31 tons per year $PM_{2.5}$.

(0.43 incidences per year), all cardiovascular-related hospital admissions (not including myocardial infarctions) (0.81 incidences per year), all respiratory-related hospital admissions (75 incidences per year), mortality (6.6 – 12 incidences per year), and nonfatal acute myocardial infarction (3.9 incidences per year for all age groups). For context, between 2020-2022, the CDPH reported that the state of California had an annual average of 322,300 mortalities from all causes and an age-adjusted death rate of 670 mortalities per 100,000 population (CDPH 2024).

Sacramento Metropolitan AQMD Strategic Area Project Health Screening Tool Results

As noted above, the Sacramento Metropolitan AQMD has developed Friant Ranch guidance and tools for projects located within the evaluated 5-Air-District Region. Project-generated emissions of feedstock and rail would occur with the Sacramento Metropolitan AQMD and Feather River AQMD jurisdiction; emissions of feedstock only would occur within El Dorado APCD and Placer County APCD jurisdiction.[11] Because the conservatively estimated maximum daily emissions would exceed the highest mass daily threshold of 82 pounds per day of NO_x assumed in the Minor Project Health Screening Tool, this evaluation uses the Strategic Area Project Health Screening tool instead, which can evaluate projects resulting in up to 8 times the emissions threshold (e.g., 656 pounds per day of VOC, NO_x, or $PM_{2.5}$). The closest strategic area location was selected for each air district scenario based on where the emissions may occur.[12]

Using the Strategic Area Project Health Screening tool, for project emissions occurring within Sacramento Metropolitan AQMD, O_3-related health outcomes attributed to project-related increases in ambient air concentrations include all respiratory-related hospital admissions (0.33 incidences per year, 0.0017% of background incidences and mortality (0.21 incidences per year, 0.00071% of background incidences). $PM_{2.5}$-related health outcomes attributed to project-related increases in ambient air concentrations include asthma-related emergency room visits (3.5 incidences per year, 0.019% of background incidences), all respiratory-related hospital admissions (1.0 incidences per year, 0.0053% of background incidences), all cardiovascular-related hospital admissions (not including myocardial infarctions) (0.61 incidences per year, 0.0025% of background incidences), and mortality (6.9 incidences per year, 0.016% of background incidences).

Similarly, based on the Strategic Area Project Health Screening tool, for project emissions occurring within Feather River AQMD, O_3-related health outcomes attributed to project-related increases in ambient air concentrations include all respiratory-related hospital admissions (0.16 incidences per year, 0.00083% of background incidences and mortality (0.1 incidences per year, 0.00034% of background incidences). $PM_{2.5}$-related health outcomes attributed to project-related increases in ambient air concentrations include asthma-related emergency room visits

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[11] The Sacramento Metropolitan AQMD Strategic Area Project Health Effects Tool assumptions include the following:
Sacramento Metropolitan AQMD: 18.41 pounds per day of VOC, 456.14 pounds per day of NO_x, and 81.15 pounds per day of $PM_{2.5}$.
Feather River AQMD: 20.11 pounds per day of VOC, 496.39 pounds per day of NO_x, and 81.99 pounds per day of $PM_{2.5}$.
El Dorado County APCD: 10.58 pounds per day of VOC, 270.99 pounds per day of NO_x, and 77.26 pounds per day of $PM_{2.5}$.
Placer County APCD: 10.58 pounds per day of VOC, 270.99 pounds per day of NO_x, and 77.26 pounds per day of $PM_{2.5}$.

[12] The following representative strategic area locations were assumed: South Sacramento for project emissions occurring within the Sacramento Metropolitan AQMD region, Woodland for project emissions occurring within the Feather River AQMD region, Rancho Cordova for project emissions occurring within the El Dorado County APCD region, and West Roseville for project emissions occurring within the Placer County ACPD region.

(0.33 incidences per year, 0.0018% of background incidences), all respiratory-related hospital admissions (0.11 incidences per year, 0.00055% of background incidences), all cardiovascular-related hospital admissions (not including myocardial infarctions) (0.055 incidences per year, 0.00023% of background incidences), and mortality (0.70 incidences per year, 0.0016% of background incidences).

For project emissions occurring within El Dorado County APCD, based on the Strategic Area Project Health Screening tool, O_3-related health outcomes attributed to project-related increases in ambient air concentrations include all respiratory-related hospital admissions (0.2 incidences per year, 0.001% of background incidences and mortality (0.13 incidences per year, 0.00043% of background incidences). $PM_{2.5}$-related health outcomes attributed to project-related increases in ambient air concentrations include asthma-related emergency room visits (1.8 incidences per year, 0.0096% of background incidences), all respiratory-related hospital admissions (0.66 incidences per year, 0.0034% of background incidences), all cardiovascular-related hospital admissions (not including myocardial infarctions) (0.38 incidences per year, 0.0016% of background incidences), and mortality (4.4 incidences per year, 0.0099% of background incidences).

For project emissions occurring within Placer County APCD, based on the Strategic Area Project Health Screening tool, O_3-related health outcomes attributed to project-related increases in ambient air concentrations include all respiratory-related hospital admissions (0.23 incidences per year, 0.0012% of background incidences and mortality (0.15 incidences per year, 0.00051% of background incidences). $PM_{2.5}$-related health outcomes attributed to project-related increases in ambient air concentrations include asthma-related emergency room visits (1.3 incidences per year, 0.0069% of background incidences), all respiratory-related hospital admissions (0.43 incidences per year, 0.0022% of background incidences), all cardiovascular-related hospital admissions (not including myocardial infarctions) (0.23 incidences per year, 0.00094% of background incidences), and mortality (2.9 incidences per year, 0.0066% of background incidences).

These results are considered conservative because the tool's outputs are based on the simulation of a full year of exposure at the maximum daily average of the increases in air pollution concentrations. As stated in the Chapter 3.2, Air Quality, of this EIR, the estimated maximum daily emissions are conservative because it was conservatively assumed that all feedstock crews would be operating in the same air district on the same day, which is unlikely in practice. Furthermore, it is more unlikely that all feedstock crews would be operating in the same air district every day of the year. For context, between 2020-2022, the CDPH reported that the counties included in the 5-Air-District Region (i.e., Sutter, Yuba, Placer, El Dorado, Sacramento, Yolo, Solano) had a total annual average of 26,652 mortalities from all causes (CDPH 2024).

Of note, the project would also result in air quality benefits associated with avoided wildfire and associated avoided criteria air pollutant emissions, which would complicate modeling as the specific location of the anticipated benefits cannot be determined at this time and those benefits are not included in the above COBRA modeling or Sacramento Metropolitan AQMD tools.

In summary, although the project has the potential to result in health effects associated with emissions of criteria air pollutants as described above, there are numerous scientific and technological complexities associated with correlating criteria air pollutant emissions from an individual project to specific health effects or potential additional nonattainment days, and methods available to quantitatively evaluate health effects may not be appropriate to apply to emissions associated with the project, which cannot be estimated with a high-level of accuracy.

Nonetheless, additional information is provided to support impact conclusions in the air quality analysis that explains what is known and what is not given constraints.

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