AIR POLLUTION CONTROL DISTRICT

IMPERIAL COUNTY
2018 ANNUAL PARTICULATE MATTER LESS THAN 2.5 MICRONS IN DIAMETER STATE IMPLEMENTATION PLAN

April 2018

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Abbreviations and Acronyms

ACT	Alternative Control Technique
AERR	Air Emissions Reporting Requirements
ANP	Annual Network Plan
AQTF	Air Quality Task Force
AQI	air quality index
AQS	Air Quality System
APCD	Air Pollution Control District
AVTD	Average Vehicle Trips per Day
BACM	Best Available Control Measure
BACT	Best Available Control Technology
BAM(s)	Beta Attenuation Monitor(s)
BECC	Border Environmental Cooperation Commission
BP	barometric pressure
CAA	Federal Clean Air Act
Caltrans	California Department of Transportation
CARB	California Air Resources Board
CaRFG	California's Reformulated Gasoline program
CBP	U.S. Customs and Border Protection
CEC	California Energy Commission
CEIDARS	California Emission Inventory Development and Reporting System
CEPAM	California Emission Projection Analysis Model
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CMP	Conservation Management Practice (agriculture)
CO	carbon monoxide
COBACH	Colegio de Bachilleres-High School
CONALEP	Colegio Nacional de Educación Profesional Técnica
CTG	Control Technique Guidelines
D.C.	District of Columbia
DM	*de minimis*
DMV	Department of Motor Vehicles
DOF	State of California Department of Finance
DPR	Department of Pesticide Regulation
DRI	Desert Research Institute
DTIM	Direct Travel Impact Model
EMFAC	EMission FACtors model
FAF	Freight Analysis Framework
FEM	Federal Equivalent Method
FRM	Federal Reference Method
GIS	Geographical Information System
hp	horsepower
HWS	horizontal wind speed

ICAPCD	Imperial County Air Pollution Control District
ICPWD	Imperial County Public Works Department
IID	Imperial Irrigation District
IRP	International Registration Plan
LCAF(s)	Large Confined Animal Facility(ies)
LEV II	Low Emission Vehicle Program
MMBtu/hr	million British thermal units per hour
MOU	Memorandum of Understanding
MPO	Metropolitan Planning Organization
NAAQS	National Ambient Air Quality Standards
NEAP	Natural Events Action Plan
NH_3	ammonia
NH_4	ammonium
NO_3	nitrate
NOx	oxides of nitrogen
NSPS	New Source Performance Standards
NSR	New Source Review
OT	Outside temperature
PM	particulate matter
$PM_{2.5}$	particulate matter less than 2.5 microns in aerodynamic diameter
PM25PRI	primary $PM_{2.5}$
PM_{10}	particulate matter less than 10 microns in aerodynamic diameter
PM10FIL	filterable PM_{10}
PMCON	condensable PM_{10}
PMPRI	primary PM_{10}
POE	ports of entry
ppm	parts per million
QA/QC	quality assurance and quality control
RACM	Reasonably Available Control Measure
RACT	Reasonably Available Control Technology
REMI	Regional Economic Models, Inc.
RFP	Reasonable Further Progress
RH	relative humidity
ROG	reactive organic gases
SCAG	Southern California Association of Governments
SCAQMD	South Coast Air Quality Management District
SCC	source classification code
SEMARNAT	Secretariat of Environment and Natural Resources
SIC	Standard Industrial Classification
SIP	State Implementation Plan
SJVAPCD	San Joaquin Valley Air Pollution Control District
SLAMS	state or local air monitoring stations
SO_2	sulfur dioxide
SO_4	sulfate
SO_X	oxides of sulfur

SPM	Special Purpose Monitor
SR	solar radiation
SSI	Size Selective Inlet
TPA	Regional Transportation Planning Agency
tpd	tons per day
tpy	tons per year
UABC	Universidad Autónoma de Baja California
UC	University of California
UPBC	Universidad Tecnologica de Baja California
U.S.	United States
USEPA	United States Environmental Protection Agency
VDT	Vehicle daily trips
VDE	Visible Dust Emissions
VOC(s)	volatile organic compound(s)
WD	wind direction
WESTAR	Western States Air Resources Council
WRAP	Western Regional Air Partnership
$\mu g/m^3$	micrograms per cubic meter
µm	micron or micrometer
ZEV	Zero Emission Vehicle

1 Introduction and Background

1.1 Introduction

This document presents the required elements of the State Implementation Plan (SIP) for the 2012 National Ambient Air Quality Standard (NAAQS) for annual concentrations of fine particulate matter less than 2.5 microns in aerodynamic diameter ($PM_{2.5}$) for the Imperial County $PM_{2.5}$ Nonattainment Area. This chapter provides an overview of particulate matter (PM) as an air pollutant, a brief description of the Imperial County area, and a discussion of the purpose, regulatory background, and regulatory agencies with responsibilities for this Imperial County Annual $PM_{2.5}$ Nonattainment Area SIP ("SIP" or "Annual $PM_{2.5}$ SIP").

As discussed below in Sections 1.2 and 1.3, the United States Environmental Protection Agency (USEPA) has currently established NAAQS for annual $PM_{2.5}$, 24-hour $PM_{2.5}$, and 24-hour PM_{10} (particulate matter less than 10 microns in aerodynamic diameter, which includes $PM_{2.5}$-sized particles). Because of the different regulatory timelines for these NAAQS, separate SIP submittals are prepared for each one. Imperial County's most recent SIP submittals regarding particulate matter include:

- 2013 SIP for the 2006 24-Hour $PM_{2.5}$ Moderate Nonattainment Area (adopted by the Imperial County Air Quality Control District [ICAPCD] in December 2014);[1]
- 2018 SIP for the Annual $PM_{2.5}$ Nonattainment Area (**this SIP document**); and
- 2018 SIP for the 24-Hour PM_{10} Nonattainment Area (a separate document, in preparation as of March 2018).

1.2 Federal $PM_{2.5}$ Standards and Implementation

The USEPA is required under Section 108 of the Clean Air Act (CAA) to periodically review and establish health-based air quality NAAQS for pollutants which "may reasonably be anticipated to endanger public health and welfare".[2] Section 109 of the CAA directs the Administrator to propose and promulgate "primary" and "secondary" NAAQS for those pollutants identified under Section 108.

On July 18, 1997, USEPA issued its final rule revising the PM NAAQS by adding two new $PM_{2.5}$ standards to the existing 24-hour average PM_{10} standard. USEPA's decision to revise the PM NAAQS was informed by available scientific evidence linking exposures to ambient PM to adverse health and welfare effects at levels allowed by the then current PM standard. Particular attention was given to several size-specific classes of particles which included $PM_{2.5}$. The two new $PM_{2.5}$ standards were an annual standard set at 15 micrograms per cubic meter (µg/m^3) based on the 3-year average of the annual arithmetic mean and a 24-hour standard of 65 µg/m^3 based on the

1 Available at: https://www.arb.ca.gov/planning/sip/planarea/imperial/Final_PM2.5_SIP_%28Dec_2,_2014%29_Approved.pdf. Accessed: November 2017.

2 USEPA. 1997. *National Ambient Air Quality Standards for Particulate Matter; Final Rule*. Federal Register. Vol. 62. No. 138. July 18, 1997. p. 38652.

3-year average of the 98th percentile 24-hour average. In 2005, Imperial County was designated as an attainment area meeting the 1997 $PM_{2.5}$ NAAQS.

On October 17, 2006,[3] USEPA strengthened the primary and secondary 24-hour $PM_{2.5}$ NAAQS from 65 µg/m^3 to 35 µg/m^3. Section 107(d)(1)(A)(i) of the CAA defines a nonattainment area as any area that does not meet an ambient air quality standard, or that contributes to ambient air quality in a nearby area that does not meet the standard. USEPA designated Imperial County as a nonattainment area for the 2006 24-hour $PM_{2.5}$ standard, effective December 14, 2009.[4] At that time, the USEPA required $PM_{2.5}$ nonattainment areas to implement Subpart 1 provisions from Part D of the CAA. Imperial County received a partial nonattainment designation for the 2006 24-hour $PM_{2.5}$ standard which includes the majority of the populated area in the county. Specifically, the $PM_{2.5}$ nonattainment area includes the portion of Imperial County that lies within the area described as follows: (San Bernardino Baseline and Meridian) beginning at the intersection of the United States-Mexico Border and the southeast corner of T17S R11E, then north along the range line of the eastern edge of range R11E, then east along the township line of the southern edge of T12S to the northeast corner of T13S R15E, then south along the range line common to R15E and R16E, to the United States-Mexico Border. The boundaries of the $PM_{2.5}$ nonattainment area are presented in Figure 1-1.

On December 14, 2012, USEPA issued a final rule revising the $PM_{2.5}$ NAAQS by lowering the primary annual $PM_{2.5}$ standard from 15 µg/m^3 to 12 µg/m^3 to provide increased protection against health effects associated with long- and short-term fine particle exposures.[5] The USEPA retained the primary 24-hour $PM_{2.5}$ standard of 35 µg/m^3 and the existing secondary (welfare-based) annual $PM_{2.5}$ standard of 15 µg/m^3. In April 2015, Imperial County was classified as a Moderate $PM_{2.5}$ nonattainment area for the annual $PM_{2.5}$ primary standard of 12 µg/m^3.[6] The $PM_{2.5}$ nonattainment area for the 2012 Annual $PM_{2.5}$ NAAQS includes the same area covered under the 2006 24-hour $PM_{2.5}$ Moderate nonattainment area, which is presented in Figure 1-1. Under the Moderate $PM_{2.5}$ nonattainment area classification, Imperial County was required to produce an Annual $PM_{2.5}$ SIP by October 2016 (18 months from the date of designation). This 2018 Annual $PM_{2.5}$ SIP demonstrates attainment of the 2012 Annual $PM_{2.5}$ NAAQS "but for" transport of international emissions from Mexico. In accordance with Section 179(B) of the CAA, the 2018 Annual $PM_{2.5}$ SIP satisfies the attainment demonstration requirement and other provisions of Subpart 1 and Subpart 4 of Part D of the CAA.

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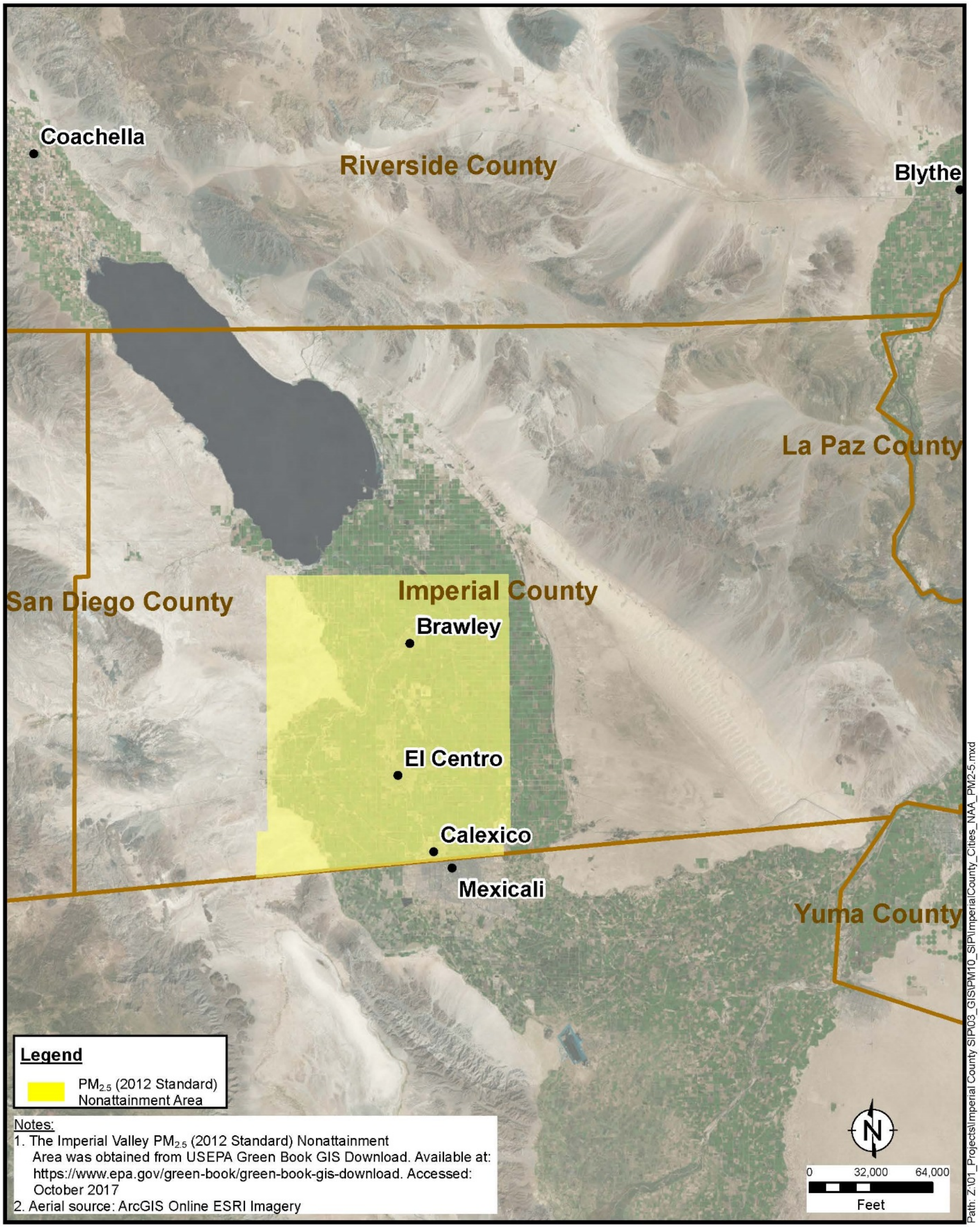
[3] USEPA. 2006. *National Ambient Air Quality Standards for Particulate Matter; Final Rule*. Federal Register. Vol. 71. No. 200. October 17, 2006. p. 61144.

[4] USEPA. 2009. *Air Quality Designations for the 2006 24-Hour Final Particle ($PM_{2.5}$) National Ambient Air Quality Standards; Final Rule*. Federal Register. Vol. 74. No. 218. November 13, 2009. p. 58688.

[5] USEPA. 2013. *National Ambient Air Quality Standards for Particulate Matter; Final Rule.* Federal Register. Vol. 78. No. 10. January 15, 2013. p. 3086.

[6] USEPA. 2015. *Air Quality Designations for the 2012 Primary Annual Fine Particle ($PM_{2.5}$) National Ambient Air Quality Standards (NAAQS); Final Rule*. Federal Register. Vol. 80. No. 10. January 15, 2015. p. 2206

Figure 1-1. Imperial County $PM_{2.5}$ Nonattainment Area



On January 4, 2013, the United States Court of Appeals for the District of Columbia (D.C.) Circuit held that the USEPA had incorrectly interpreted the CAA with respect to statutory requirements for the implementation of the 1997 $PM_{2.5}$ NAAQS. The D.C. Circuit remanded the final "Clean Air Fine Particle Implementation Rule"[7] and the "Implementation of the New Source Review (NSR) Program for Particulate Matter Less than 2.5 micrometers ($PM_{2.5}$)" final rule[8] with instructions to “repromulgate” these rules pursuant to Subpart 4 of Part D of the CAA. The Court’s reasoning explained that the plain meaning of the CAA required implementation of the 1997 $PM_{2.5}$ NAAQS under Subpart 4 because $PM_{2.5}$ particles fall within the statutory definition of PM_{10} and are thus subject to the same statutory requirements. As a result, the USEPA instructed states to implement Subpart 1 and Subpart 4 provisions as a part of the $PM_{2.5}$ SIP development process. Under Subpart 4 provisions, Imperial County was classified as a Moderate $PM_{2.5}$ nonattainment area in accordance to CAA Section 188(a).

One of Imperial County's unique features is also its greatest challenge when trying to improve air quality. Imperial County is one of California's international gateways. In particular, the city of Calexico shares a border with the densely populated city of Mexicali, Mexico. The primary reason for elevated $PM_{2.5}$ levels in Imperial County is emissions transport from Mexico. On December 2, 2014, Imperial County adopted the Imperial County 2013 SIP for the 2006 24-hour $PM_{2.5}$ Moderate Non-Attainment Area (“2013 $PM_{2.5}$ SIP”). The 2013 $PM_{2.5}$ SIP demonstrated attainment of the 2006 24-hour $PM_{2.5}$ NAAQS “but for” transport of international emissions from Mexico. In accordance with Section 179(B) of the CAA, the 2013 $PM_{2.5}$ SIP satisfied the attainment demonstration requirement satisfying the provisions of Subpart 1 and Subpart 4 of Part D of the CAA.

The Role of Mexico Emissions

Historical measurements and previous SIP submittals, such as the 2013 24-Hour $PM_{2.5}$ SIP, show that emissions from Mexico can dominate local $PM_{2.5}$ concentrations, particularly near the border. The CAA allows for a demonstration of attainment ‘but for’ international emission transport, but the local area must still meet many CAA requirements, as shown in this SIP.

Elements in this revision to the SIP for the Imperial County $PM_{2.5}$ nonattainment area consist of the following:

- Base year emission inventories and future year forecasts for manmade sources of directly emitted $PM_{2.5}$ and $PM_{2.5}$ precursors;
- A comprehensive precursor demonstration;

[7] USEPA. 2007. *Clean Air Fine Particulate Implementation Rule; Final Rule.* Federal Register. Vol. 72. No. 79. April 25, 2007. p. 20586.
[8] USEPA. 2008. *Implementation of the New Source Review (NSR) Program for Particulate Matter Less than 2.5 micrometers ($PM_{2.5}$); Final Rule.* Federal Register. Vol. 73. No. 96. May 16, 2008. p. 28321.

- An attainment demonstration;
- Demonstration that control measures meet Reasonably Available Control Technology (RACT), Reasonably Available Control Measures (RACM), and Additional Reasonable Measures (ARM) requirements, as applicable;
- Requirements for Reasonable Further Progress (RFP);
- Contingency measures for RFP;
- Quantitative milestones; and
- Transportation conformity emission budgets to ensure transportation projects are consistent with the SIP.

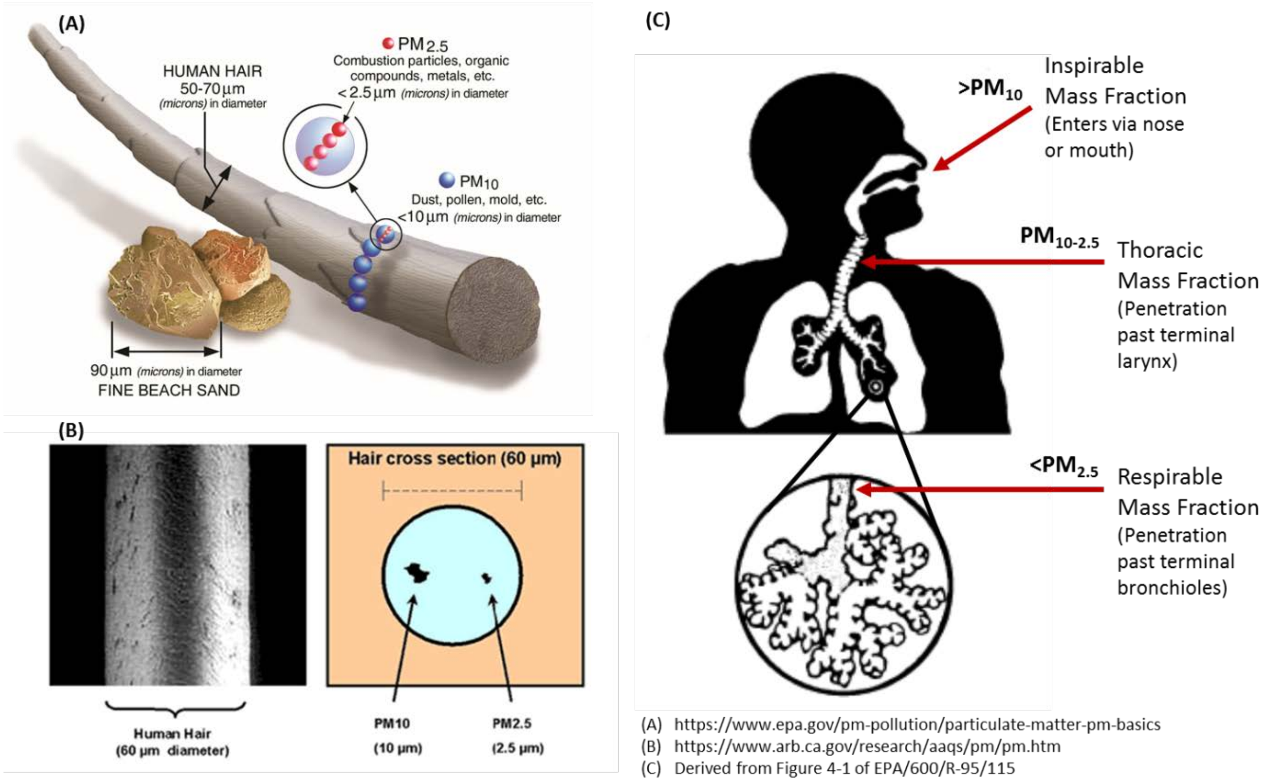
1.3 Particulate Matter Air Pollution and Health Effects

Particulate matter is a general term used to describe a complex group of airborne solid, liquid, and semi-volatile materials of various sizes and compositions. Primary PM is emitted directly into the atmosphere by both human activities (including agricultural operations, industrial processes, construction and demolition activities, and entrainment of road dust into the air) and non-anthropogenic activities (such as windblown dust and ash resulting from forest fires). Secondary PM is formed in the atmosphere from predominantly gaseous combustion by-product precursors, such as sulfur and nitrogen oxides (SO_X and NO_X), and volatile organic compounds (VOCs). The relative proportion of primary and secondary PM in a given geographic area can vary widely depending upon such factors as the mix of sources in the area, the mix of PM precursors, and local meteorology. In addition, PM and its precursors can be transported hundreds or thousands of miles while suspended in the atmosphere.[9] Consequently, ambient PM in an area may be the combination of primary and secondary particles that result from the emissions from both local and remote sources.

Federal and state regulators have established both PM_{10} and $PM_{2.5}$ as separate criteria pollutants based, in part, on how the human body reacts to the particles of different sizes. Figure 1-2 shows the relative sizes of PM_{10} and $PM_{2.5}$, as well as how far they travel into the human body.

[9] National Research Council. 2010. *Global Sources of Local Pollution: An Assessment of Long-Range Transport of Key Air Pollutants to and from the United States*. Washington, DC: The National Academies Press. Available at: https://doi.org/10.17226/12743. Accessed: January 2018.

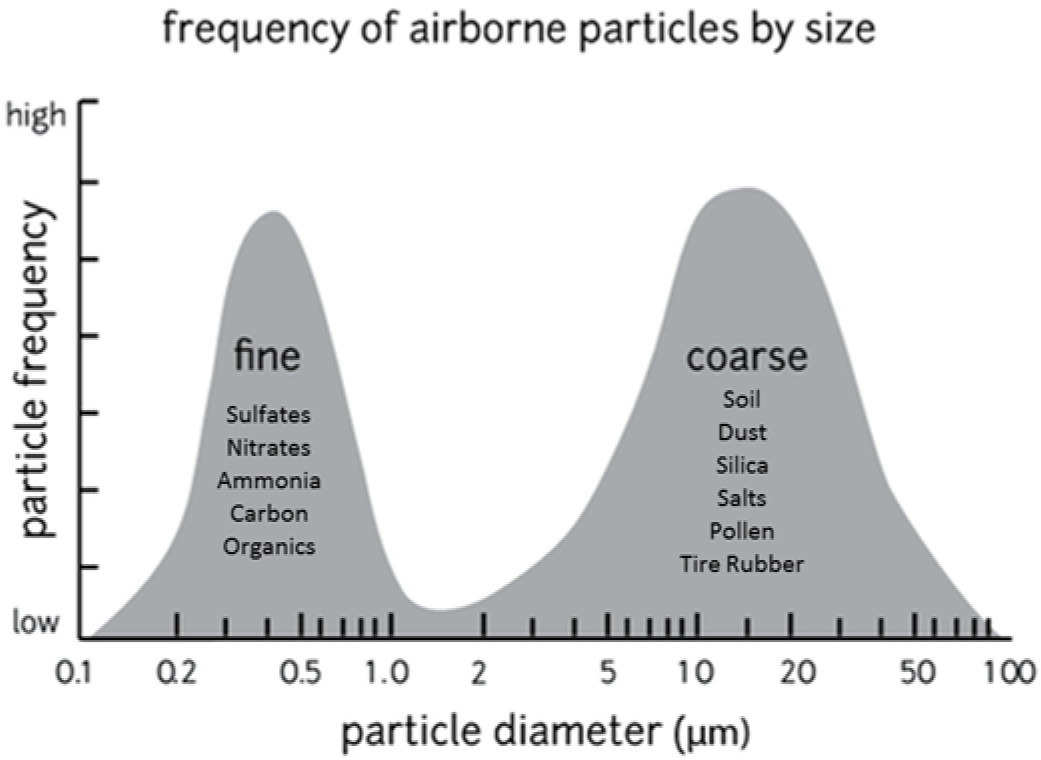
Figure 1-2. $PM_{2.5}$ and PM_{10} Relative Sizes and Health Impact Pathways



(A) https://www.epa.gov/pm-pollution/particulate-matter-pm-basics
(B) https://www.arb.ca.gov/research/aaqs/pm/pm.htm
(C) Derived from Figure 4-1 of EPA/600/R-95/115

Classification of particulate matter as PM_{10} and $PM_{2.5}$ is based on the size of the particulates; however, they also have different components. Although PM_{10} includes all "fine" $PM_{2.5}$-sized particulates, it also includes "coarse" primary particulates such as dust resulting from both activities (e.g., construction, mining, etc.) and entrainment from soil surfaces by the wind. Figure 1-3 is a general schematic of the components in fine and coarse PM; the relative contribution depends on how the different sources are represented in a given area.

Figure 1-3. Properties and Sources of $PM_{2.5}$ and PM_{10}



Derived from https://publiclab.org/wiki/revisions/pm/25078

Common constituents of ambient $PM_{2.5}$ include: sulfate (SO_4^{2-}), nitrate (NO_3^-), ammonium (NH_4^+), elemental carbon, a variety of organic compounds, and inorganic materials (including metals, dust, sea salt, and other trace elements), which often are referred to as "crustal" materials. These $PM_{2.5}$ species, or chemical compounds, are summarized in Table 1-1.

Table 1-1. Primary $PM_{2.5}$ Species

Species	Description
Organic Carbon	Directly emitted, primarily from combustion sources (e.g., residential wood combustion). Also, smaller amounts attached to geological material and road dust. May also be emitted directly by natural sources (biogenic).
Elemental Carbon	Also called soot or black carbon; incomplete combustion (e.g., diesel engines).
Geologic Material	Road dust and soil dust that are entrained in the air from activity, such as soil disturbance or airflow from traffic.
Trace Metals	Identified as components from soil emissions or found in other particulates having been emitted in connection with combustion from engine wear, brake wear, and similar processes. Can also be emitted from fireworks.
Sea Salt	Sodium chloride in sea spray where sea air is transported inland.

Table 1-1. Primary $PM_{2.5}$ Species

Species	Description
Secondary Organic Carbon	Secondary particulates formed from photochemical reactions of organic carbon.
Ammonium Nitrate	Reaction of ammonia and nitric acid, in which the nitric acid is formed from nitrogen oxide emissions via photochemical processes or during night-time reactions with ozone.
Ammonium Sulfate	Reaction of ammonia and sulfuric acid, in which the sulfuric acid is formed primarily from sulfur oxide emissions via photochemical processes, with smaller amounts forming from direct emissions of sulfur.
Combined Water	A water molecule attached to one of the above molecules.

1.3.1 $PM_{2.5}$ Air Pollution and Health Effects

$PM_{2.5}$ is an extremely small airborne particle and can penetrate deeply into the lungs of people who inhale it, where it can accumulate, react, or be absorbed into the body. Epidemiological studies have shown a significant association between elevated $PM_{2.5}$ levels and a number of serious health effects, including premature mortality, aggravation of respiratory and cardiovascular disease (as indicated by increased hospital admissions, emergency room visits, absences from school or work, and restricted activity days), lung disease, decreased lung function, asthma attacks, and certain cardiovascular problems such as heart attacks and cardiac arrhythmia. Individuals particularly sensitive to $PM_{2.5}$ exposure include older adults, people with heart or lung disease, and children.

$PM_{2.5}$ has undesirable and detrimental environmental effects on vegetation, both directly (e.g., deposition of nitrates and sulfates may cause direct foliar damage) and indirectly (e.g., coating of plants upon gravitational settling reduces light absorption). $PM_{2.5}$ also accumulates to form regional haze, which reduces visibility due to scattering of light. Agencies concerned with haze include the National Park Service, the United States Forest Service, the Western Regional Air Partnership (WRAP), and the Western States Air Resources Council (WESTAR).

1.4 Imperial County

1.4.1 Geography, Population, and Land Use

Imperial County extends over 4,284 square miles[10] in the southeastern portion of California, bordering Mexico to the south, Riverside County to the north, San Diego County to the west, and the State of Arizona to the east. The Imperial Valley runs approximately north-to-south through the center of the county and extends into Mexico. The terrain elevation varies from as low as

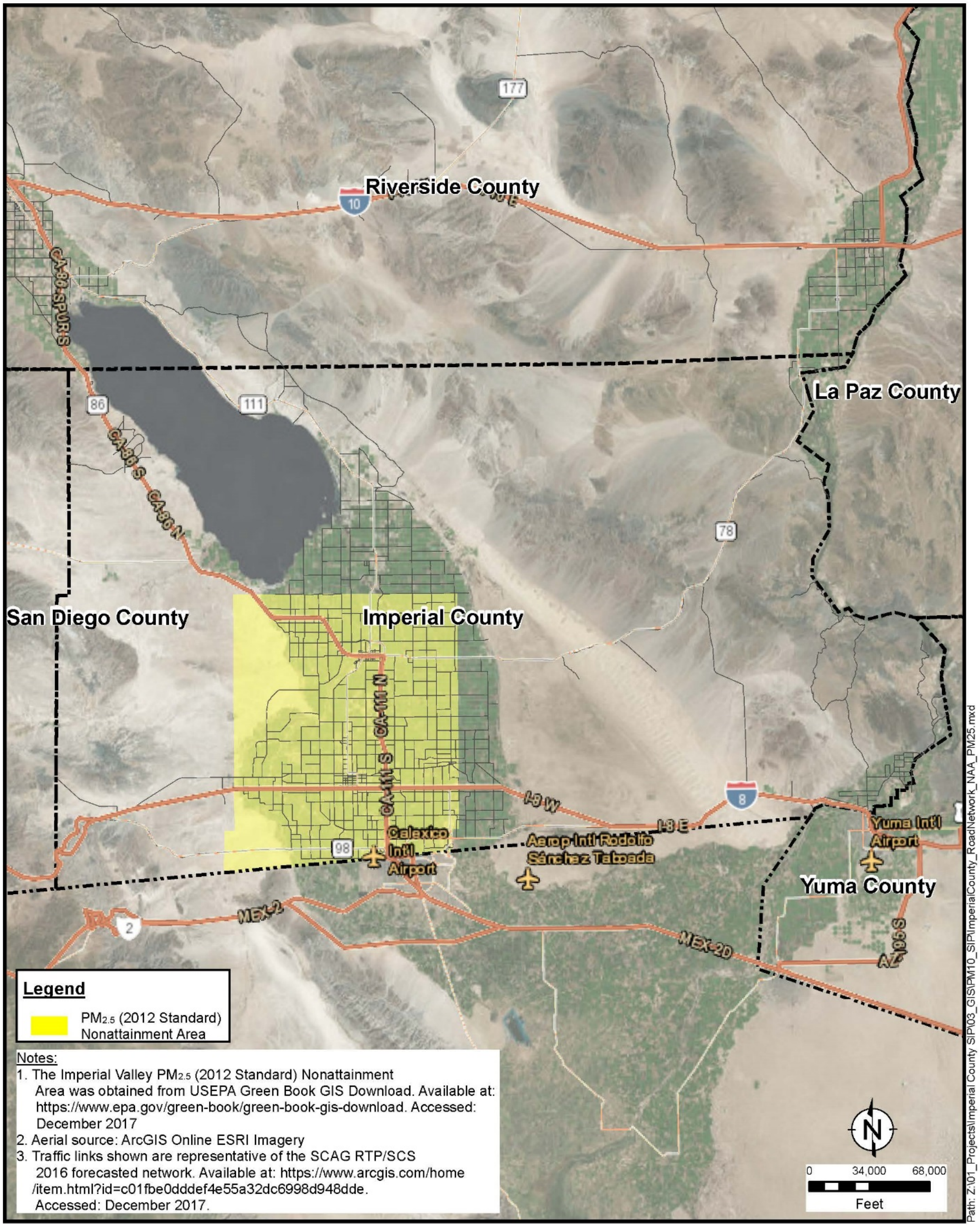
[10] Official website of Imperial County, http://www.co.imperial.ca.us/.

230 feet below sea level at the Salton Sea to the north to more than 2,800 feet above sea level at the mountain summits to the east.

As of July 1, 2016, Imperial County's population is approximately 180,883 people[11] and its principal industries are farming and retail trade. Most of the population, farming, and retail trade exists in a band of land that, on average, comprises less than one-fourth the width of the County, stretching from the south shore of the Salton Sea to the United States-Mexico border. The road network is densest within this strip, as shown in Figure 1-4. It also connects the three most populated cities in the county, which are Brawley, El Centro, and Calexico. Their populations are about 26,500, 45,000, and 38,500, respectively. The rest of Imperial County is the Salton Sea and mostly dry, barren desert areas with little to no human population.

[11] U.S. Census Bureau Quick Facts 2016, https://www.census.gov/quickfacts/fact/table/imperialcountycalifornia

Figure 1-4. Road Map of Imperial County



The area contains relatively few major $PM_{2.5}$ emission sources, but can experience significant vehicular traffic, particularly near Calexico, given its proximity to an international port of entry into the United States. Other significant sources of direct $PM_{2.5}$ in the region are unpaved road dust, fugitive windblown dust, farming operations, managed burning and disposal, and aircraft.

1.5 Regulatory Responsibility

Federal, state, and local agencies participate in the planning process for attaining air quality in compliance with the NAAQS. The roles of the multiple agencies involved are outlined in this section.

1.5.1 United States Environmental Protection Agency

The USEPA administers the provisions of the federal CAA and other legislation related to air quality. A principal function of the USEPA is to set the NAAQS and promulgate new regulations based on the scientific evidence of the health and environmental effects of pollutants. In addition, the USEPA establishes national emission limits for major sources of air pollution, regulates emissions from locomotives, aircraft, and other mobile sources most effectively controlled at the national level, inspects and monitors emission sources, and provides financial and technical support for air quality research and development programs.

The USEPA enforces federal air quality laws. Under the CAA, the USEPA is authorized to require states to prepare plans to attain the NAAQS by deadlines specified in the CAA. SIPs, which are intended to outline specific pollution control strategies for each federal nonattainment area within a state, are prepared by regional and county air pollution control districts in collaboration with state agencies and with the USEPA, who is ultimately responsible for the SIP final review and approval.

Under the CAA, the USEPA also has authority to impose sanctions for failure to submit a plan or failure to carry out commitments in a plan. Sanctions include increased emissions offsets requirements for major stationary sources and withholding of federal highway funds.

1.5.2 California Air Resources Board

The California Air Resources Board (CARB) is the state agency responsible for the coordination and administration of both state and federal air pollution control programs in California. CARB undertakes research, sets state ambient air quality standards as well as emission standards for motor vehicles, provides technical assistance to local districts, compiles emission inventories, provides modeling of air pollution, develops suggested control measures, and provides oversight of district control programs. An important function of CARB is to coordinate and guide regional and local air quality planning efforts required by the California Clean Air Act, and to prepare and submit air quality management plans to the USEPA.

1.5.3 Imperial County Air Pollution Control District

The Imperial County Air Pollution Control District (ICAPCD or “District”) shares responsibility with CARB for ensuring that all state and federal ambient air quality standards are achieved and maintained within the County. The ICAPCD is responsible for monitoring ambient air quality and has authority to regulate stationary sources and some area sources of emissions. The ICAPCD is responsible for developing the overall attainment strategy for Imperial County, and therefore, is responsible for planning activities involving the development of emission inventories, quantification of emission reductions, and comparison of emission reduction strategies.

Air districts in state nonattainment areas are also responsible for developing and implementing transportation control measures necessary to locally achieve ambient air quality standards. In doing so, air districts cooperate with local transportation commissions and Regional Transportation Planning Agencies (RTPAs) in the development of the transportation control measures adopted within a SIP. Under the conformity requirements of the CAA (1977, 1990), Imperial County's TPAs cannot approve any Regional Transportation Plan[12] or Transportation Improvement Program[13] that does not conform to the SIP's purpose of expeditiously bringing the area into attainment of the NAAQS.

[12] A Regional Transportation Plan is a county's master plan outlining policies, actions, and financial projections to guide investment decisions over a 20-year horizon.

[13] A Transportation Improvement Program specifies all highway and transit projects spanning a multi-year period, that are either regionally significant or that require federal funding or approval.

2 Ambient and Air Quality Data

2.1 Introduction

Air quality is a function of both the rate and location of pollutant emissions under the influence of meteorological conditions and topographic features. Atmospheric conditions such as wind speed, wind direction, and air temperature gradients, along with local topography, influence the movement and dispersal of pollutants and thereby provide the link between air pollutant emissions and air quality.

This chapter provides an overview of the impact of climate and meteorology on the dispersion of particulate matter, a description of the local air monitoring network, and an overview of $PM_{2.5}$ data collected and its temporal and spatial patterns within Imperial County.

2.2 Climate and Meteorology

Climatic conditions in Imperial County are governed by the large-scale sinking and warming of air in the semi-permanent tropical high pressure center of the Pacific Ocean. The high pressure ridge blocks out most mid-latitude storms except in winter when it is weakest and farthest south. The coastal mountains prevent the intrusion of any cool, damp air found in California coastal environments. Because of the weakened storms and barrier, Imperial County experiences clear skies, extremely hot summers, mild winters, and little rainfall. The flat terrain of the valley and the strong temperature differentials created by intense solar heating produce moderate winds and deep thermal convection.

Winters are mild and dry with daily average temperature ranges between 65 and 75ºF (18-24ºC). During winter months it is not uncommon to record maximum temperatures of up to 80ºF. Summers are extremely hot with daily average temperatures ranging between 104 and 115ºF (40-46ºC). It is not uncommon during summer months to record maximum temperatures of 120ºF. The annual rainfall is just over 3 inches (7.5 cm) with most of it coming in late summer or midwinter.

Humidity is low throughout the year, ranging from 28 percent in summer to 52 percent in winter. The large daily oscillation of temperature produces a corresponding large variation in the daily relative humidity. Nocturnal humidity rises to 50-60 percent, but drops to about 10 percent during the day. Summer weather patterns are dominated by intense heat induced by low-pressure areas that form over the interior desert.

The predominant wind patterns in the border region are from the northwest during the fall through spring and southeast during the summer. Under stagnant conditions, pollutants within the Calexico-Mexicali air shed tend to accumulate. The greatest numbers of low wind speed episodes occur October through February. Occasionally, Imperial County experiences periods of extremely high wind speeds. Wind speeds can exceed 30 miles per hour (mph), occurring most frequently during the months of April and May. However, speeds of less than 6.8 mph account for more than half of all the observed wind measurements.

2.2.1 Atmospheric Stability and Dispersion

Air pollutant concentrations are primarily determined by the amount of pollutant emissions in an area and the degree to which these pollutants are dispersed in the atmosphere. The stability of the atmosphere is one of the key factors affecting pollutant dispersion. Atmospheric stability regulates the amount of vertical and horizontal air exchange, or mixing, that can occur within a given air basin. Restricted mixing and low wind speeds are generally associated with a high degree of stability in the atmosphere. These conditions are characteristic of temperature inversions. A temperature inversion is simply a layer of cool air trapped below a warmer layer of air, whereby the normal gradient of air temperature with increasing altitude is reversed. Figure 2-1 shows that this reversal of the normal pattern impedes the upward flow of air, causes poor dispersion, and traps pollutants near the surface. Imperial County experiences surface inversions almost every day of the year, caused by cooling of the air layer in contact with the cold surface of the earth (due to radiational cooling) at night. Because of strong surface heating during the day, these inversions are usually broken, allowing pollutants to disperse more easily. However, the presence of the North Pacific High pressure cell can cause the air to warm to a temperature higher than the air below. This highly stable atmospheric condition, termed a subsidence inversion, can act as a nearly impenetrable lid to the vertical mixing of pollutants. The strength of these inversions makes them difficult to disrupt. Consequently, they can persist for one or more days, causing air stagnation and the build-up of pollutants. This frequently leads to elevated concentrations of pollutants developing near the densely populated city of Mexicali, Mexico and then transporting north to impact the border city of Calexico and other areas of the County.

Figure 2-1. Example of a Temperature Inversion[14]

[14] Figure is from https://www.epa.gov/sites/production/files/2017-01/air-quality-inversion-diagram.gif. Accessed: November 2017.

2.3 Imperial County Air Monitoring Network

Imperial County began its ambient air quality monitoring program in 1976. Since that time, federal regulatory ambient air monitoring in Imperial County has been a collaborative effort between the ICAPCD and CARB. The primary purpose of any ambient air monitoring is to protect public health and welfare.

Depending on the purpose and air quality designation of an area, the monitoring stations present may be of many different types. In Imperial County, all monitoring stations are designated as state or local air monitoring stations (SLAMS). Per the Code of Federal Regulations (CFR), all SLAMS are ambient air quality monitoring sites that are primarily used for comparison to the NAAQS. There are two types of NAAQS that an air district must consider: the primary standard which provides for the protection of public health and the secondary standard which provides for the protection of public welfare which includes protection against decreased visibility and damage to animals, crops, vegetation and buildings. Therefore, the placement of any ambient air monitor is essential for meeting that monitor's objective. Objectives are determined after evaluation of spatial scales of representativeness, levels of concentration, and purpose. In particular, the spatial scale of representativeness defines the distance over which pollutant concentrations are expected to be the same, given similar emission sources and meteorological conditions. A properly established monitor should target the key data collection need identified by the monitoring objective and spatial scale of the site. Therefore, the physical placement of the ambient air monitor varies depending on the evaluated monitoring objective.

Table 2-1 below is a representation of the existing $PM_{2.5}$ monitors established at the Brawley, El Centro, and Calexico stations. The Calexico station is located approximately 1 mile north of the International Border with Mexico. Because of Calexico's close proximity to the international border, there exists a common air shed between Calexico and Mexicali. Having a shared international air shed supports the recognition of international impacts within the border region and is evident in plans and efforts such as the Border 2020 Program.[15] Figure 2-2 is a depiction of the air sheds and areas that are providing monitoring data along the United States-Mexico border.

[15] More information available at: https://www.epa.gov/border2020. Accessed: October 2017.

Table 2-1. $PM_{2.5}$ Network Monitoring Equipment (2012-2015)	
Station	**2012 - 2015**
Brawley	R&P 2025 FRM
El Centro	R&P 2025 FRM
Calexico	2 – R&P 2025 FRM 1 – Thermo 2025 FRM 2 – Thermo 2025i FRM 2 – Met One BAM 1020 FEM 2 – Speciation (SASS and URG)
Abbreviations: BAM - Beta Attenuation Monitor FEM - Federal Equivalent Method FRM - Federal Reference Method R&P- Pupprecht & Patashnick Co, Inc. SASS - Speciation Air Sampling System Thermo - ThermoFisher Scientific URG - URG Corporation	

Figure 2-2. Air Sheds and Areas along the US-Mexico Border[16]

16 Fig. 2-2 from http://www.epa.gov/ttn/catc/cica/geosel_e.html.

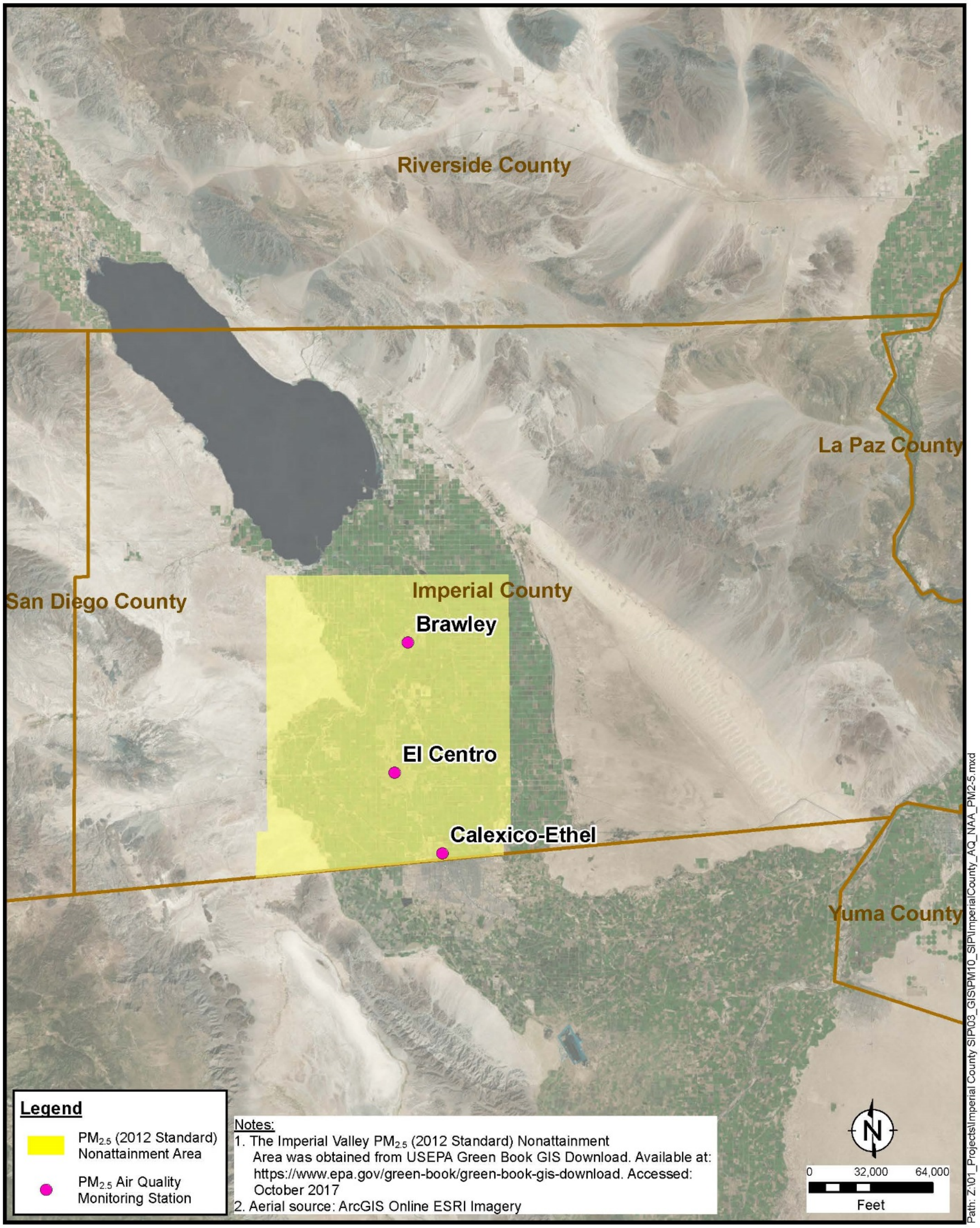
Analysis of data from the Calexico station indicates that along with capturing emissions within the localized area, the monitors are downwind recipients of concentrations from international sources and therefore their measurements incorporate emission sources from outside the United States.

2.3.1 $PM_{2.5}$ Monitoring Stations in Imperial County

In Imperial County there are three $PM_{2.5}$ air monitoring stations located within the populated cities of Brawley, El Centro, and Calexico (Figure 2-3). In addition to running USEPA-approved Federal Reference Method (FRM) $PM_{2.5}$ monitors, these stations measure meteorological parameters such as horizontal wind speed (HWS), wind direction (WD), outside temperature (OT), relative humidity (RH), barometric pressure (BP), and solar radiation (SR). The 2015 Annual Network Plan for Imperial County (ANP) describes the cities of Brawley, El Centro, and Calexico as homogeneous, urban sub-regions with similar land use and land surface characteristics.[17] Because of this, it is appropriate to compare the $PM_{2.5}$ concentrations and meteorological data from all three stations. It is, however, important to note that the 2015 ANP identifies the Calexico station as consistently recording the highest concentrations of $PM_{2.5}$. Appendix A provides additional data comparisons and analyses between the stations located in Calexico, El Centro, and Brawley.

[17] CARB. 2015. Annual Monitoring Network Report for Twenty-Five Districts in California. Volumes 1 and 2. June. Available at: http://www.co.imperial.ca.us/AirPollution/index.asp?fileinc=airmonitoring. Accessed: February 2018.

Figure 2-3. Ambient Air Monitoring Stations in the Imperial County $PM_{2.5}$ Nonattainment Area

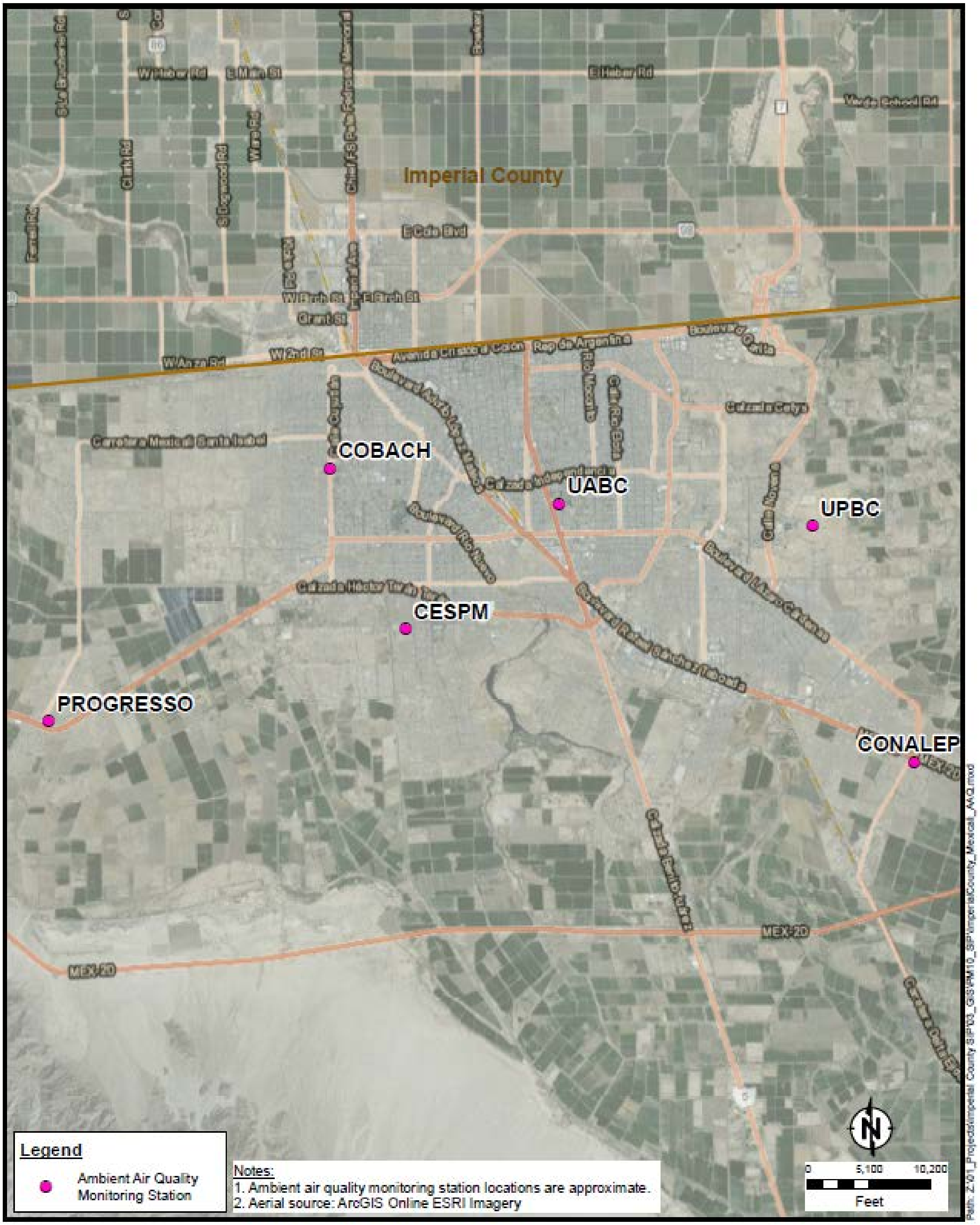


2.3.2 $PM_{2.5}$ Monitoring Stations in Mexicali, Mexico

The ambient air monitoring network in Mexicali began installing, configuring, and testing monitors in July 1996. Through an initial collaborative effort between the USEPA and CARB, and with the participation of the Secretaría de Medio Ambiente y Recursos Naturales (Mexico's federal environmental agency and USEPA counterpart, also known as SEMARNAT), the air monitoring network in Mexicali began operation in January 1997. The network was composed of six stations, four of which monitored continuously for ozone, NO_X, carbon monoxide (CO), SO_2, and $PM_{2.5}$, while the remaining two stations monitored PM_{10} using high volumetric samplers. Additionally, these stations measured certain meteorological parameters, such as temperature, humidity, and wind speed and direction. Figure 2-4 shows the following established stations: Universidad Autónoma de Baja California (UABC), Colegio de Bachilleres-High School (COBACH), Universidad Tecnológica de Baja California (UPBC), CESPM Xochmilco, Colegio Nacional de Educación Profesional Técnica (CONALEP), and Progresso. UABC and COBACH are located in the urban center of Mexicali near the border, approximately 2.6 and 2 miles from the Calexico-Ethel Station, respectively. Both of these stations monitor continuously for $PM_{2.5}$ using Beta Attenuation Monitors (BAMs).

Unfortunately, since 1997, monitored data from the Mexicali ambient air monitoring network has been inconsistent, with large gaps occurring regularly. For this reason, a contract was put in place to improve the reliability of air quality monitoring data at two sites in Mexicali to better understand the current sources as well as the temporal profile of the $PM_{2.5}$ in the area. In 2016, USEPA funded a contract with SCS Tracer to provide monitoring in Mexicali. The purpose of this project is to collect a two-year data set of $PM_{2.5}$ and meteorology at two existing monitoring sites in Mexicali. The $PM_{2.5}$ data set will include continuous $PM_{2.5}$ as well as discrete samples that will be analyzed for certain chemical species. Monitoring data began being collected in April 2016 and will run through April 2018. The contractor is running an hourly $PM_{2.5}$ BAM, a wind and temperature sensor, $PM_{2.5}$ speciation, and carbon sampling at the UABC site. In addition, the contractor is running an hourly $PM_{2.5}$ BAM, as well as a wind and temperature sensor at the COBACH monitoring site. This data set will assist in the determination of the extent that $PM_{2.5}$ emissions in Mexicali have on air quality in Calexico.

Figure 2-4. Mexicali Ambient Air Monitoring Network



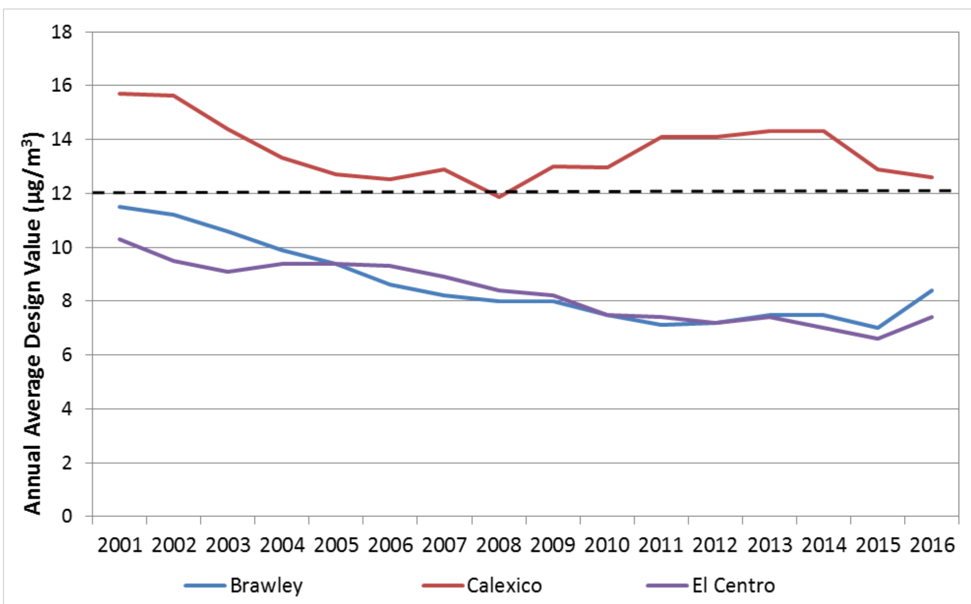
2.4 Ambient Air Quality Data

The 2012 $PM_{2.5}$ NAAQS of 12 µg/m³ is based on the three-year average of the annual arithmetic mean. According to the CAA, the assessment of an area's air quality for the preparation of a SIP is based on the most recent three years of complete data. Air quality data of importance in the preparation of Imperial County's $PM_{2.5}$ SIP corresponds to the years 2012-2014. However, 2015 and 2016 data were included for analysis and are subsequently presented and included in the discussion below.

2.4.1 Imperial County $PM_{2.5}$ Air Quality

Border communities such as Calexico are unique areas where many different people come together and cross geopolitical boundaries. Residents on both sides of the border share a common environment and have similar exposures to pollutants. Observed traffic and commuting patterns within the Calexico/Mexicali border area are typically home-to-work and work-to-home. While it would seem that the most evident exposure along the Calexico/Mexicali border relates to traffic emissions, there are emissions from other sources such as electrical generation, other industrial sources, unpaved roads, and to some extent, cultural practices. Despite the challenges of geography, climate, and proximity to Mexico, air quality in Imperial County has improved except for in the border area. The annual design values for Calexico, El Centro, and Brawley (Figure 2-5) illustrate how different Calexico air quality is from both El Centro and Brawley. Figure 2-5 shows that the air quality in Brawley and El Centro has improved with a general reduction in the annual average design value since 2001. However, in Calexico, air quality has not improved as much and remains above the federal annual average $PM_{2.5}$ standard of 12 µg/m³.

Figure 2-5. 2001-2016 Average Annual Design Values for Calexico, El Centro, and Brawley



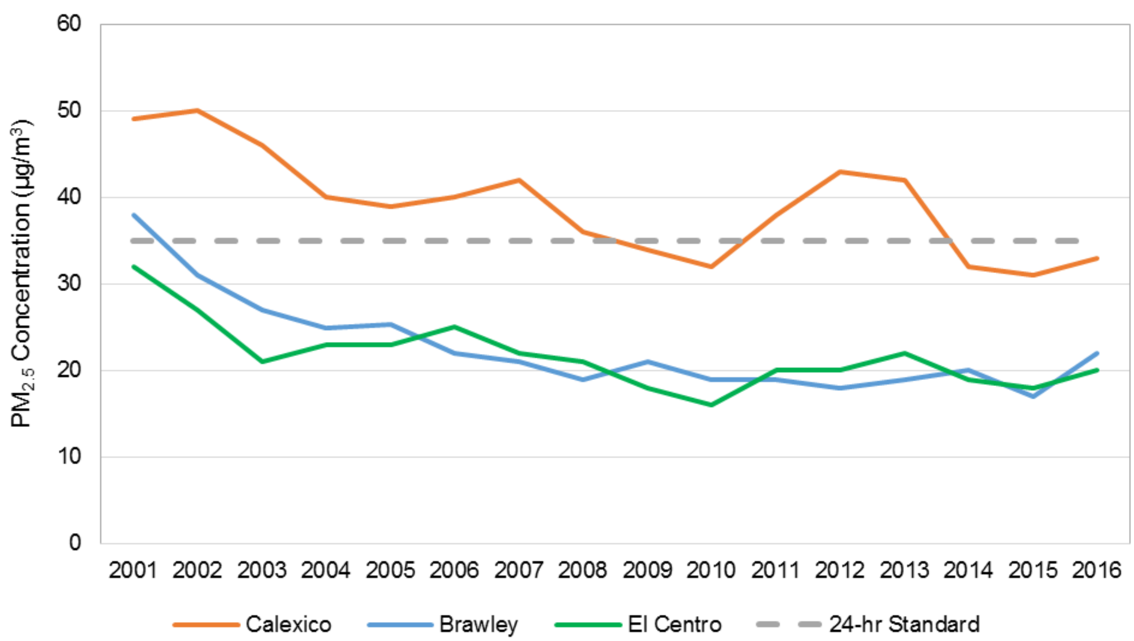
** The 2015 design value shown above is 12.9 µg/m³ and does not include data from the Special Purpose Monitor (SPM) that was included in 2015 at Calexico. USEPA's Air Quality System (AQS) includes data from the SPM in quarters 1 and 4 of 2015, which results in a design value of 13.1 µg/m³.*

The CAA 179(B) Analysis (Appendix A) discusses in detail the chemical mass balance speciated data which indicates that the Calexico $PM_{2.5}$ is comprised primarily of carbonaceous aerosols (organic matter [OM] plus elemental carbon [EC]). The analysis further identifies that the carbonaceous aerosol particles are a significant contributor to elevated $PM_{2.5}$ levels throughout the year, peaking during the winter months. Known carbonaceous aerosol sources in urban areas include burning, cooking, and motor vehicle exhaust.

The speciation discussion in the 179(B) Analysis also indicates that geological dust is the second highest contributor to $PM_{2.5}$ at Calexico and is largely due to the surrounding large expanses of desert and arid regions in the air shed. The geological component remains fairly constant throughout the months, with slight increases in the fall and early winter months.

The previously mentioned indications lend evidence that Calexico is impacted by transport of pollution from Mexicali. To add further evidence, Figure 2-6 shows that the 24-hour design values have hovered at or above the 24-hour standard of 35 µg/m³ at the Calexico-Ethel station. By contrast, the 24-hour design values for El Centro and Brawley have generally stayed below the 24-hour standard for the same period of time. These observations indicate that the further the station is from the border region, the less impact it has on the monitor's measurements.

Figure 2-6. 24-Hr $PM_{2.5}$ Design Value Trends (FRM Data)



3 Emissions Inventory

3.1 Introduction

Emissions inventories are one of the fundamental building blocks in the development of a SIP. In simple terms, an emissions inventory is a systematic listing of the sources of air pollution along with the amount of pollution emitted from each source or category over a given time period. This Chapter describes the emissions inventory for the Imperial County $PM_{2.5}$ Nonattainment Area.

CARB and the District have developed a comprehensive, accurate, and current emissions inventory consistent with the requirements set forth in Section 182(a)(1) of the CAA. CARB and District staff conducted a thorough review of the inventory to ensure that the emission estimates reflect accurate emission reports for point sources, and that estimates for mobile and areawide sources are based on the most recent models and methodologies.

CARB also reviewed the growth profiles for point and areawide source categories and updated them as necessary to ensure that the emission projections are based on data that reflect historical trends, current conditions, and recent economic and demographic forecasts. Growth forecasts for most point and areawide sources were developed either by CARB or by the Southern California Association of Governments (SCAG) and provided to CARB through the South Coast Air Quality Management District (SCAQMD). SCAG is the metropolitan planning organization (MPO) representing Imperial County, along with five other counties in Southern California.

3.2 Emissions Inventory Overview

Emissions inventories are estimates of the amount and type of pollutants emitted into the atmosphere by industrial facilities, mobile sources, and areawide sources such as consumer products and paint. They are fundamental components of an air quality plan, and serve critical functions such as:

1) the primary input to air quality modeling used in attainment demonstrations;
2) the emissions data used for developing control strategies; and
3) a means to track progress in meeting the emission reduction commitments.

USEPA regulations require that the emissions inventory for a $PM_{2.5}$ SIP contain emissions data for directly emitted $PM_{2.5}$ and its precursors: NO_X, SO_X, VOCs, and NH_3. The inventory included in this Plan substitutes VOC with reactive organic gases (ROG), which in general represent a slightly broader group of compounds than those in USEPA's list of VOCs.

3.3 Agency Responsibilities

CARB and District staff worked jointly to develop the emissions inventory for Imperial County and the Imperial $PM_{2.5}$ Nonattainment Area. The District worked closely with operators of major stationary facilities in their jurisdiction to develop the point source emission estimates. CARB staff developed the emission inventory for mobile sources, both on-road and off-road. The District and CARB shared responsibility for developing estimates for the nonpoint (areawide) sources such as paved road dust and agricultural burning. CARB worked with several State and local agencies such as the Department of Transportation (Caltrans), the Department of Motor Vehicles (DMV), the Department of Pesticide Regulation (DPR), and the California Energy Commission (CEC) to assemble activity information necessary to develop the mobile and areawide source emission estimates.

3.4 Inventory Base Year

The base year inventory forms the basis for all future year projections and also establishes the emission levels against which progress in emission reductions will be measured. USEPA regulations establish that the base year inventory should be preferably consistent with the triennial reporting schedule required under the Air Emissions Reporting Requirements (AERR) rule. However, USEPA allows a different year to be selected if justified by the state. CARB worked with the local air districts to determine the base year that should be used across the State. Since the SCAQMD typically aligns their base year inventory with the data collection period for their Multiple Air Toxics Exposure Study, which was last conducted in 2012, CARB selected 2012 as the base year to maintain consistency across the various plans being developed in the State.

3.5 Forecasted Inventories

In addition to a base year inventory, USEPA regulations also require future year inventory projections for specific milestone years. Forecasted inventories are a projection of the base year inventory that reflects expected growth trends for each source category and emission reductions due to adopted control measures. CARB develops emission forecasts by applying growth and control profiles to the base year inventory.

Growth profiles for point and areawide sources are derived from surrogates such as economic activity, fuel usage, population, housing units, etc., that best reflect the expected growth trends for each specific source category. Growth projections were obtained primarily from government entities with expertise in developing forecasts for specific sectors, or in some cases, from econometric models. Control profiles, which account for emission reductions resulting from adopted rules and regulations, are derived from data provided by the regulatory agencies responsible for the affected emission categories.

Projections for mobile source emissions are generated by models that predict activity rates and vehicle fleet turnover by vehicle model year. As with stationary sources, the mobile source models include control algorithms that account for all adopted regulatory actions.

3.6 Temporal Resolution

Planning inventories typically include annual as well as seasonal (summer and winter) emission estimates. Annual emission inventories represent the total emissions over an entire year (tons per year), or the daily emissions produced on an average day (tons per day). Seasonal inventories account for temporal activity variations throughout the year, as determined by category-specific temporal profiles. Since this Plan reflects an annual $PM_{2.5}$ standard, the emission inventory used in the Plan is an annual inventory.

3.7 Geographical Scope

The inventories presented in this Plan consist of emissions for the Imperial $PM_{2.5}$ Nonattainment Area, which represents a portion of Imperial County. Typically, emission inventories are developed at a county-level geographical resolution. The county level emissions were allocated to the nonattainment area using the approach described below.

- **Stationary Sources.** Emissions from stationary sources were designated as being inside or outside the nonattainment area based on a Geographical Information System (GIS) analysis of each facility's geographical coordinates (latitude and longitude) overlaid on a digitized map of the nonattainment area.
- **Areawide Sources.** District staff conducted a thorough review of the areawide categories to determine those that actually occur in the nonattainment area, and their emissions were allocated based on spatial surrogates (e.g., paved road miles, forest land acreage, human population, etc.) that best reflect the expected distribution of these sources. In assigning the spatial surrogates, CARB staff prioritized the source categories based on their NOx, SOx and direct $PM_{2.5}$ emissions, and selected those above a threshold level of 0.1 tons per day for further review. Human population was set as the default surrogate, but more precise, category-specific surrogates were selected when data were available. Categories below the 0.1 ton per day threshold were assigned human population as the spatial surrogate.
- **On-Road Mobile Sources.** For this Plan, a pre-existing spatial surrogate was used to distribute emissions to the nonattainment area based on EMFAC2011/Direct Travel Impact Model (DTIM) gridded NOx outputs. This gridded spatial surrogate was originally used to distribute EMFAC2011[18] emissions among grid cells inside and outside the nonattainment area for the original Imperial 2012 $PM_{2.5}$ Plan. This NOx surrogate was used to distribute emissions for all pollutants. This same spatial surrogate was used to distribute updated EMFAC2014 emissions to the nonattainment area for this Plan.
- **Off-Road Mobile Sources.** As with areawide sources, District staff were consulted to determine the extent of emission activity occurring in the nonattainment area. Of these categories, aircraft emissions occurred fully in the nonattainment area and all other sources were allocated based on human population.

The emission inventory allocation methods are summarized in Table 3-1 below.

[18] EMission FACtors, CARB's on-road mobile sources model: https://www.arb.ca.gov/msei/categories.htm.

Table 3-1. Methods for the Spatial Allocation of Emissions to the Imperial $PM_{2.5}$ Nonattainment Area

Source Category	Allocation Method
Stationary Point Sources	GIS Analysis
Areawide Sources:	
I.C. Reciprocating Engines	Human Population/Industrial Employment
Agricultural Irrigation I.C. Engines	Irrigated Cropland Acreage
Residential Fuel Combustion	Human Population
Farming Operations – Tilling Dust	Human Population
Farming Operations – Feedlot Cattle	Average monthly cattle head counts in NA
Construction and Demolition	Human Population
Paved Road Dust	Human Population
Unpaved Road Dust	Human Population
Fugitive Windblown Dust	GIS Analysis
Agricultural Burning	Percent of Agricultural Cropland in NA
On-Road Mobile Sources	Direct Travel Impact Model Analysis
Off-Road Mobile Sources:	
Aircraft	100% in Nonattainment Area
Other than Aircraft	Human Population

3.8 Quality Assurance and Quality Control

CARB has established a quality assurance and quality control (QA/QC) process involving CARB and District staff to ensure the integrity and accuracy of the emissions inventories used in the development of air quality plans. QA/QC occurs at the various stages of SIP emission inventory development. Base year emissions are assembled and maintained in the California Emission Inventory Development and Reporting System (CEIDARS). CARB inventory staff works with District staff, who are responsible for developing and reporting point source emission estimates, to verify these data are accurate. The locations of point sources, including stacks, are checked to ensure they are valid. Areawide source emission estimates are reviewed by CARB and District staff before their inclusion in the emission inventory. Additionally, CEIDARS is designed with automatic system checks to prevent errors such as double counting of emission sources. The system also makes various reports available to assist staff in their efforts to identify and reconcile anomalous emissions.

Future year emissions are estimated using the California Emission Projection Analysis Model (CEPAM), 2016 SIP Baseline Emission Projections, Version 1.05. Growth and control factors are reviewed for each category and year along with the resulting emission projections. Year to year trends are compared to similar and past datasets to ensure general consistency. Emissions for specific categories are checked to confirm they reflect the anticipated effects of applicable control measures. Mobile categories are verified with mobile source staff for consistency with the on-road and off-road emission models.

A summary of the information supporting the Imperial $PM_{2.5}$ Nonattainment Area SIP emissions inventory is presented in the sections below.

3.9 Point Sources

The nonattainment area contains only a limited number of facilities that generate direct $PM_{2.5}$ emissions or other $PM_{2.5}$ precursors such as NOx, SOx, ROG, and ammonia. The inventory reflects actual emissions from industrial point sources reported to the District by the facility operators through calendar year 2012, in accordance with the requirements set forth in USEPA's AERR rule. The data elements in the 2012 baseline inventory are consistent with the data elements required by the AERR rule. Estimation methods include source testing, direct measurement by continuous emissions monitoring systems, or engineering calculations.

The point source categories that occur in the $PM_{2.5}$ nonattainment area are listed below in Table 3-2.

Table 3-2. Point Source Categories

Source Category	Subcategory
Fuel Combustion	Electrical Utilities
	Cogeneration
	Manufacturing and Industrial
	Food and Agricultural Processing
	Service and Commercial
	Other (I.C. Reciprocating Engines)
Waste Disposal	Sewage Treatment
	Landfills
	Other
Cleaning and Surface Coatings	Laundering
	Degreasing
	Coatings and Thinners
	Adhesives and Sealants

Table 3-2. Point Source Categories

Source Category	Subcategory
Petroleum Production and Marketing	Petroleum Refining
	Petroleum Marketing
	Other (Petroleum Production & Marketing)
Industrial Processes	Food and Agriculture
	Mineral Processes

The point source inventory includes emissions from stationary area sources, which are categories such as internal combustion engines and gasoline dispensing facilities that are not inventoried individually, but are estimated as a group and reported as an aggregated total. Estimates for the following categories were developed by CARB:

3.9.1 Stationary Nonagricultural Diesel Engines

This category includes emissions from backup and prime generators and pumps, air compressors, and other miscellaneous stationary diesel engines that are widely used throughout the industrial, service, institutional, and commercial sectors. The emission estimates, including emission forecasts, are based on a 2003 CARB methodology derived from the OFFROAD model. Additional information on this methodology is available at: https://www.arb.ca.gov/ei/areasrc/FULLPDF/FULL1-2.pdf.

3.9.2 Agricultural Diesel Irrigation Pumps

This category includes emissions from the operation of diesel-fueled stationary and mobile agricultural irrigation pumps. The emission estimates are based on a 2003 CARB methodology using statewide population and include replacements due to the Carl Moyer Program. Emissions are grown based on projected acreage for irrigated farmland. Additional information on this category is available at: https://www.arb.ca.gov/ei/areasrc/arbfuelcombagric.htm.

3.9.3 Waste Disposal, Composting Facilities

This category includes emissions from composting facilities that process organic materials via an open windrow composting or aerated static pile processes. The emission estimates are based on a 2015 CARB methodology using facility specific emissions testing or an emission factor derived from testing at composting facilities. No growth is assumed for future years. Additional information on this methodology is available at: https://www.arb.ca.gov/ei/areasrc/index2.htm.

3.9.4 Laundering

This category includes emissions from perchloroethylene (perc) dry cleaning establishments. The emission estimates are based on a 2002 CARB methodology that used nationwide perc consumption rates allocated to the county level based on population and an emission factor of 10.125 pounds per gallon used. Emissions were grown from the original estimates to 2012 using human population growth trends from SCAG. Additional information on this methodology is available at: https://www.arb.ca.gov/ei/areasrc/onehtm/one3-1.htm.

3.9.5 Degreasing

This category includes emissions from solvents in degreasing operations in the manufacturing and maintenance industries. The emissions estimates are based on a 2000 CARB methodology using survey and industry data, activity factors, emission factors and a user's fraction. Growth for this category is based on CARB/Regional Economic Models, Inc. (REMI) industry-specific economic output. Additional information on this methodology is available at: https://www.arb.ca.gov/ei/areasrc/arbcleandegreas.htm.

3.9.6 Coatings and Thinners

This category includes emissions from coatings and related process solvents. Auto refinishing emissions estimates are based on a 1990 CARB methodology using production data and a composite emission factor derived from surveys. Growth is based on projected vehicle miles traveled (VMT) provided by SCAG. Estimates for industrial coatings emissions are based on a 1990 CARB methodology using production and survey data, and emission factors derived from surveys. Estimates for thinning and cleaning solvents are based on a 1991 CARB methodology, census data and a default emission factor developed by CARB. Growth for these categories is projected using CARB/REMI industry-specific economic output and employment. Additional information on these methodologies is available at: https://www.arb.ca.gov/ei/areasrc/arbcleancoatreproc.htm.

3.9.7 Adhesives and Sealants

This category includes emissions from solvent-based and water-based solvents contained in adhesives and sealants. Emissions are estimated based on a 1990 CARB methodology using production data and default emission factors. Growth for this category is based on CARB/REMI industry-specific economic output. Additional information on this methodology is available at: https://www.arb.ca.gov/ei/areasrc/arbcleanadhseal.htm.

3.9.8 Gasoline Dispensing Facilities

CARB staff developed an updated methodology to estimate emissions from fuel transfer and storage operations at gasoline dispensing facilities (GDFs). The methodology addresses emissions from underground storage tanks, vapor displacement during vehicle refueling, customer spillage, and hose permeation. The updated methodology uses emission factors developed by CARB staff that reflect more current in-use test data and also accounts for the emission reduction benefits of onboard refueling vapor recovery (ORVR) systems. The emission estimates are based on the 2012 statewide gasoline sales data from the California Board of Equalization that were apportioned to the county level using fuel consumption estimates from EMFAC. Additional information on this category is available at: https://www.arb.ca.gov/ei/areasrc/arbpetprodmarkpm.htm.

3.10 Areawide Sources

Areawide sources are categories such as consumer products, unpaved road dust, fireplaces, and prescribed burning for which emissions occur over a wide geographic area. Emissions for these categories are estimated by both CARB and the local air districts using various models and methodologies. The areawide sources are listed below in Table 3-3.

Table 3-3. Areawide Sources

Source Category	Subcategory
Solvent Evaporation	Consumer Products
	Architectural Coatings and Related Solvents
	Pesticides/Fertilizers
	Asphalt Paving and Roofing
Miscellaneous Processes	Residential Fuel Combustion
	Farming Operations
	Construction And Demolition
	Paved Road Dust
	Unpaved Road Dust
	Fugitive Windblown Dust
	Fires
	Managed Burning and Disposal
	Cooking
	Other (Miscellaneous Processes)

A summary of the areawide methodologies is presented below:

3.10.1 Ammonia Emissions from Publicly Owned Treatment Works, Landfills, Composting, Fertilizer Application, Domestic Activity, Native Animals, and Native Soils

CARB staff updated the ammonia emissions inventory methodology for publicly owned treatment works, landfills, composting, fertilizer application, domestic activity, native animals, and native soils. Revisions for these categories consist primarily of updated activity data for the 2008 calendar year. Emission factors were revised only for fertilizer application.

3.10.2 Ammonia Emissions, Miscellaneous Sources

Ammonia emissions from miscellaneous domestic processes (human respiration and perspiration, smoking, pets, untreated human waste, etc.) were grown from a 2005 CARB estimate using State of California Department of Finance (DOF) population projections. Ammonia emissions for other categories such as residential wood combustion, livestock husbandry, managed burning, and on-road motor vehicles, were estimated as part of the methodologies for those specific area source categories.

3.10.3 Consumer Products

The consumer products category reflects the four most recent surveys conducted by CARB staff for the years 2003, 2006, 2008, and 2010. Together these surveys collected updated product information and ingredient information for approximately 350 product categories. Based on the survey data, CARB staff determined the total product sales and total VOC emissions for the various product categories. The growth trend for most consumer product subcategories is based on the latest SCAG human population growth projections, except for aerosol coatings. Staff determined that a no-growth profile would be more appropriate for aerosol coatings based on survey data that show relatively flat sales of these products over the last decade. Additional information on CARB's consumer products surveys is available at: https://www.arb.ca.gov/consprod/survey/survey.htm.

3.10.4 Architectural Coatings

The architectural coatings category reflects emission estimates based on a comprehensive CARB survey for the 2004 calendar year. The emission estimates include benefits of the 2000 and 2007 CARB Suggested Control Measures. These emissions are grown based on SCAG projections for number of households. Additional information about CARB's architectural coatings program is available at: https://www.arb.ca.gov/coatings/arch/arch.htm.

3.10.5 Pesticides

DPR develops month-specific emission estimates for agricultural and structural pesticides. Each calendar year, DPR updates the inventory based on the Pesticide Use Report, which provides updated information from 1990 to the most current data year available. The inventory includes estimates through the 2014 calendar year. Emission forecasts for years 2015 and beyond are based on the average of the most recent five years. Growth for agricultural pesticides is based on CARB projections of harvested acreage provided by the U.S. Department of Agriculture (USDA). Growth for structural pesticides is based on CARB projections of housing expenditures.

3.10.6 Asphalt Paving/Roofing

Asphalt paving emissions for 2012 were estimated using a District methodology, and asphalt roofing emissions were grown from a 2005 estimate. Emissions are estimated based on tons of asphalt applied and a default emission factor for each type of asphalt operation. The growth profile for both categories is based on construction employment from the CARB/REMI forecasting model. Additional information on the District's methodology is available at: https://www.arb.ca.gov/ei/areasrc/distsolevapasphpav.htm.

3.10.7 Residential Wood Combustion

CARB staff updated the methodology to reflect 2005 fuel use, and more recent emission factors and calculation approaches. The emission estimates reflect emission factors from USEPA's

National Emission Inventory. No growth is assumed for future years. Additional information on this methodology is available at: https://www.arb.ca.gov/ei/areasrc/arbmiscprocresfuelcom.htm.

3.10.8 Farming Operations

CARB staff updated the inventory based on CARB methodologies for Agricultural Land Preparation and Agricultural Harvest Operations to reflect 2012 harvested crop acreage from the USDA's National Agricultural Statistics Service (NASS). NASS data are based on reports compiled by County Agricultural Commissioner staff. Emissions reflect crop and operation specific emission factors. Temporal profiles were updated based on crop specific activity profiles. In addition, the inventory reflects the emission reductions from District Rule 806. Growth is based on projected harvested acreage. The methodologies are available at: https://www.arb.ca.gov/ei/areasrc/arbmiscprocresfarmop.htm.

CARB staff updated the Livestock Husbandry methodology to reflect livestock population data based on the USDA's 2007 Census of Agriculture, and ammonia emission factors for dairy support cattle. A seasonal adjustment was added to account for the suppression of dust emissions in months in which rainfall occurs. Animal populations and emission factors for feedlots and dairies were updated for 2012 based on District data and California specific testing. CARB projects growth for feedlot cattle based on county livestock report data. Based on an analysis of livestock population trends, no growth is assumed for other livestock categories. In addition, the inventory reflects emission reductions from District Rules 420 and 217. Additional information on CARB's methodology is available at: https://www.arb.ca.gov/ei/areasrc/arbmiscproclivestock.htm. Additional information on the District's update is available here: https://www.arb.ca.gov/ei/areasrc/districtmeth/imperial/2016mar16_dairyfeedlotops.pdf.

3.10.9 Construction and Demolition

Emission estimates for building construction and road construction were grown from CARB estimates developed in 2002 and 1997, respectively. The growth profile for both categories is based on construction employment from the CARB/REMI forecasting model. In addition, the inventory reflects emission reductions from District Rules 801, 802 and 805. Additional information on this methodology is available at: https://www.arb.ca.gov/ei/areasrc/arbmiscprocconstdem.htm.

3.10.10 Paved Road Dust

Paved road dust emissions for 2012 were estimated using a CARB methodology consistent with the current USEPA method (AP-42). The emission estimates are based on VMT provided by SCAG, California-specific silt loading values, VMT distribution (travel fractions) for various paved road categories, and an Imperial County specific rain adjustment. Emissions were grown using VMT projections from SCAG. The inventory also reflects the emission reductions from District Rules 803 and 805. Additional information is available at: https://www.arb.ca.gov/ei/areasrc/arbmiscprocpaverddst.htm.

3.10.11 Unpaved Road Dust – Farm Roads

Emissions for unpaved farm roads were updated based on CARB's methodology and 2012 harvested crop acreage from NASS. Emissions reflect crop specific VMT factors and an emission factor based on California test data conducted by the University of California, Davis (UC Davis), and the Desert Research Institute (DRI). Temporal profiles were updated based on crop specific activity profiles. Growth for this category is based on harvested acreage. In addition, the inventory reflects the emission reductions from District Rule 806. The methodology is available at: https://www.arb.ca.gov/ei/areasrc/arbmiscprocunpaverddst.htm.

3.10.12 Unpaved Nonfarm Road Dust

Emissions from unpaved nonfarm roads were estimated from 2008 unpaved road data collected from the California Statewide Local Streets and Roads Needs Assessment, Caltrans, and local agencies. Dust emissions were calculated using an emission factor derived from tests conducted by UC Davis and DRI. In addition, a rainfall adjustment factor was applied. Staff assumed no growth for this category based on the assumption that existing unpaved roads tend to get paved as vehicle traffic on them increases, which counteracts any additional emissions from new unpaved roads. The inventory also reflects the emission reductions from District Rule 805. Additional information on this methodology is available at: https://www.arb.ca.gov/ei/areasrc/arbmiscprocunpaverddst.htm.

3.10.12.1 Fugitive Windblown Dust from Open Areas and Non-pasture Agriculture Lands

The District provided estimates of windblown fugitive dust derived from a model developed by Ramboll Environ under a contract with the District. The model assesses emission characteristics, hourly emission factors and hourly meteorological data for each land parcel within the modeling domain, and applies correction terms based on vegetative cover, as well as non-climatic corrections for agricultural lands. Based on these inputs, the model was used to estimate fugitive windblown dust emission from open areas and non-pasture agriculture lands in the Imperial County $PM_{2.5}$ Nonattainment Area. Growth for agricultural lands is based on projected acreage from the California Department of Conservation's Farmland Mapping and Monitoring Program (FMMP). No growth is assumed for non-agricultural lands. The inventory also reflects the emission reductions from District Rules 804 and 806. Additional information about CARB's methodology is available at:
https://www.arb.ca.gov/ei/areasrc/arbmiscprocfugwbdst.htm.

3.10.13 Windblown Dust from Unpaved Roads

Emissions for this source category were estimated based on a 1997 CARB methodology reflecting unpaved road mileage and local parameters that affect wind erosion. The estimates assume no growth. Additional information on this methodology is available at: https://www.arb.ca.gov/ei/areasrc/arbmiscprocfugwbdst.htm.

3.10.14 Fires

Emissions from structural and automobile fires were estimated based on a 1999 CARB methodology using the number of fires and the associated emission factors. Estimates for structural fires are calculated using the amount of the structure that is burned, the amount and content of the material burned, and emission factors derived from test data. Estimates for automobile fires are calculated using the weight of the car and components and composite emission factors derived from AP-42 emission factors. No growth is assumed for this category.

Additional information on this methodology is available at: https://www.arb.ca.gov/ei/areasrc/arbmiscprocfires.htm.

3.10.15 Managed Burning & Disposal

CARB updated the emissions inventory to reflect burn data reported by District staff for 2012. Emissions are calculated using crop specific emission factors and fuel loadings. Temporal profiles reflect monthly burn activity. Growth for agricultural burning is based on projected harvested acreage. No growth is assumed for burning associated with weed abatement. CARB's methodology for managed burning is available at: https://www.arb.ca.gov/ei/areasrc/distmiscprocwstburndis.htm. Additional background information is available here: https://www.arb.ca.gov/ei/see/see.htm.

3.10.16 Commercial Cooking

Commercial cooking emissions were grown from a 2005 estimate. The emissions estimates were developed from the number of restaurants, the number and types of cooking equipment, the food type, and default emission factors. The growth profile reflects the latest population projections provided by SCAG.

3.11 Point and Areawide Source Emissions Forecasting

Emission forecasts (2013 and subsequent years) are based on growth profiles that in many cases incorporate historical trends up to the base year or beyond. The growth surrogates used to forecast the emissions from these categories are presented below in Table 3-4.

Table 3-4. Growth Surrogates for Point and Areawide Sources

Source Category	Subcategory	Growth Surrogate
Fuel Combustion	Electric Utilities	SoCAL Gas Company (SCG) 2014 report
	Cogeneration	ARB/REMI industry-specific economic output
	Manufacturing and Industrial Area Source/Natural Gas	SCG 2014 report
	Manufacturing and Industrial Others	ARB/REMI industry-specific economic output
	Food and Agricultural Processing Ag Irrigation I.C. Engines	Modeled estimate
	Food and Agricultural Processing Point Sources	ARB/REMI industry-specific economic output
	Service and Commercial Natural Gas	SCG 2014 Report
	Service and Commercial Other Fuels	CARB/REMI industry-specific employment
	Other, Diesel	CARB EMFAC model for fuel consumption
	Other Fuels	CARB/REMI industry specific economic output/employment
Waste Disposal	Sewage Treatment	SCAG population
	Landfills	SCAG population
	Other (Composting)	No growth
Laundering	Dry Cleaning	SCAG population
Degreasing	All	CARB/REMI industry-specific economic output
Coatings & Thinners	Auto Refinishing	SCAG Vehicle Miles Traveled (VMT)
	Others	CARB/REMI industry specific economic output/employment
Adhesives & Sealants	All	CARB/REMI industry-specific economic output

Table 3-4. Growth Surrogates for Point and Areawide Sources

Source Category	Subcategory	Growth Surrogate
Petroleum Refining	All	CARB EMFAC model fuel consumption
Petroleum Marketing	All	CARB EMFAC model fuel consumption
Petroleum Production & Marketing	All	CARB/REMI industry-specific economic output
Food & Agriculture	All	CARB/REMI industry specific economic output
Mineral Processes	All	CARB/REMI industry-specific economic output/employment
Other Industrial Processes	Electrical Power Generation	SCG 2014 report
	Others	CARB/REMI industry-specific economic output
Consumer Products	Consumer Products	SCAG population
	Aerosol Coatings	No growth
Architectural Coatings and Related Process Solvents	All	SCAG households
Pesticides/Fertilizers	Agricultural Pesticides	Harvested acreage
	Structural Pesticides	CARB housing expenditure
Asphalt Paving/Roofing	All	CARB/REMI industry-specific employment
Residential Fuel Combustion	Natural Gas	SCG 2014 report
	Woodstoves & Fireplaces - Wood	No growth
	Water Heating	SCAG households
	Cooking	SCAG households
	Other	SCAG households
Farming Operations	Tilling & Harvest Operations	Harvested acreage
	Livestock / Feedlot Cattle	County livestock report data/ARB
	Livestock / Others	No growth
Construction & Demolition	All	CARB/REMI industry-specific employment

Table 3-4. Growth Surrogates for Point and Areawide Sources

Source Category	Subcategory	Growth Surrogate
Paved Road Dust	All	SCAG VMT
Unpaved Road Dust	Farm Roads	Harvested acreage
	Others	No growth
Fugitive Windblown Dust	Agricultural & Pasture Lands	CARB FMMP data
	Others	No growth
Fires	All	No growth
Managed Burning & Disposal	Agricultural Burning, Prunings & Field Crops	Harvested acreage
	Weed Abatement	No growth
Cooking	All	SCAG population
Other (Miscellaneous Processes)	All	SCAG population

3.12 Stationary Source Control Profiles

The emissions inventory reflects emission reductions from point and areawide sources subject to District rules and CARB regulations. The rules and regulations reflected in the inventory are listed below in Table 3-5.

Table 3-5. District and CARB Stationary Source Control Rules and Regulations Included in the Inventory

Agency	Rule/Reg No.	Rule Title	Source Categories Impacted
District	217	Large Confined Animal Facilities (LCAF) Permits Required	Livestock Husbandry
District	420	Beef Feedlots	Livestock Operations
District	801	Construction and Earthmoving Activities	Construction and Demolition
District	802	Bulk Materials	Point Sources
District	803	Carry-Out and Track-Out	Paved Roads
District	804	Open Areas	Windblown Dust
District	805	Paved and Unpaved Roads	Paved and Unpaved Non-farm Roads

Table 3-5. District and CARB Stationary Source Control Rules and Regulations Included in the Inventory

Agency	Rule/Reg No.	Rule Title	Source Categories Impacted
District	806	Conservation Management Practices	Tilling and Harvesting Operations, Windblown Dust, Unpaved Farm Roads
CARB	AC_SCM2007	Architectural Coatings 2007 SCM	Architectural coatings
CARB	ARCH_SCM	Architectural Coatings 2000 SCM	Architectural coatings
CARB	CARB_R003	Consumer Product Regulations & Amendments	Consumer products
CARB	CARB_R003_A	Consumer Product Regulations & Amendments	Consumer products
CARB	CARB_R007	Aerosol Coating Regulation	Consumer products / Aerosol coatings
CARB	GDF_HOSREG	Gasoline Dispensing Facilities - Hose Permeation	Petroleum marketing
CARB	ORVR	Fueling emissions from ORVR vehicles	Petroleum marketing

3.13 Mobile Sources

CARB uses the EMFAC model to assess emissions from on-road vehicles. Off-road mobile source emissions are estimated using a new modular approach for different source categories. On-road and off-road models account for the effects of various adopted regulations, technology types, and seasonal conditions on emissions.

3.13.1 On-Road Mobile Sources

Emissions from on-road mobile sources, which include passenger vehicles, buses, and trucks, were estimated using outputs from CARB's EMFAC2014 model. The on-road emissions were calculated by applying EMFAC2014 emission factors to the transportation activity data provided by SCAG from their 2016 adopted Regional Transportation Plan/Sustainable Communities Strategy (2016 RTP/SCS).

EMFAC2014 includes data on California's car and truck fleets and travel activity. Light-duty motor vehicle fleet age, vehicle type, and vehicle population were updated based on 2012 DMV data. The model also reflects the emissions benefits of CARB's recent rulemakings such as the Pavley Standards and Advanced Clean Cars Program, and includes the emissions benefits of CARB's Truck and Bus Rule and previously adopted rules for other on-road diesel fleets.

EMFAC2014 utilizes a socio-econometric regression modeling approach to forecast new vehicle sales and to estimate future fleet mix. Light-duty passenger vehicle population includes 2012 DMV registration data along with updates to mileage accrual using Smog Check data. Updates to heavy-duty trucks include model year specific emission factors based on new test data, and population estimates using DMV data for in-state trucks and International Registration Plan (IRP) data for out-of-state trucks.

Additional information and documentation on the EMFAC2014 model is available at: https://www.arb.ca.gov/msei/categories.htm#emfac2014.

3.13.2 Off-Road Mobile Sources

Emissions from off-road sources were estimated using a suite of category-specific models or, where a new model was not available, the OFFROAD2007 model. Many of the newer models were developed to support recent regulations, including in-use off-road equipment, ocean-going vessels and others. The sections below summarize the updates made to specific off-road categories.

Cargo Handling Equipment (CHE)

The emissions inventory for the Cargo Handling Equipment category has been updated to reflect new information on equipment population, activity, recessionary impacts on growth, and engine load. The new information includes regulatory reporting data which provide an accounting of all the cargo handling equipment in the State including their model year, horsepower and activity. Background and supporting documents for the Cargo Handling Equipment Regulation are available here: https://www.arb.ca.gov/ports/cargo/cheamd2011.htm

Pleasure Craft and Recreational Vehicles

A new model was developed in 2011 to estimate emissions from pleasure craft and recreational vehicles. In both cases, population, activity, and emission factors were re-assessed using new surveys, registration information, and emissions testing. Additional information is available at: https://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles.

In-Use Off-Road Equipment

CARB developed this model in 2010 to support the analysis for amendments to the In-Use Off-Road Diesel Fueled Fleets Regulation. Staff updated the underlying activity forecast to reflect more recent economic forecast data, which suggests a slower rate of recovery through 2024 than previously anticipated. Additional information is available at: https://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles.

Locomotives

In 2016, CARB updated California's Class I and Class II line-haul locomotive model. The new model provides the following updates: age and model year distribution based on 2011 and 2014 rail company data, activity based on Freight Analysis Framework (FAF) data, fuel growth based on Board of Equalization historical rail data, and new locomotive populations, survival rates, and Tier distributions. To estimate emissions, CARB used duty cycle, fuel consumption and activity data reported by the rail lines in 2011. These results were combined with the Class III locomotive emissions inventory from previous SIPS, that were incorporated in the 2006 locomotive inventory, to create an overall California line-haul locomotive emissions inventory for the SIP. More information may be found at https://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles.

Transport Refrigeration Units (TRU)

This model reflects updates to activity, population, growth and turn-over data, and emission factors developed to support the 2011 amendments to the Airborne Toxic Control Measure for In-Use Diesel-Fueled Transport Refrigeration Units. Additional information is available at: https://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles.

Fuel Storage and Handling

Emissions for fuel storage and handling were estimated using the OFFROAD2007 model. Additional information is available at: https://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles.

Diesel Agricultural Equipment

The inventory for agricultural diesel equipment (such as tractors, harvesters, combines, sprayers and others) was revised based on a 2008 survey of thousands of farmers, custom operators, and first processors. The survey data, along with information from the 2007 USDA Farm Census, was used to revise almost every aspect of the agricultural inventory, including population, activity, age distribution, fuel use, and allocation. This updated inventory replaces general information on farm equipment in the United States with one specific to California farms and practices. The updated inventory was compared against other available data sources such as Board of Equalization fuel reports, USDA tractor populations and age, and Eastern Research Group tractor ages and activity, to ensure the results were reasonable and compared well against outside data sources. Agricultural growth rates through 2050 were developed through a contract with URS Corp and UC Davis. Additional information is available at: https://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles.

Military Aircraft

Baseline emission estimates were developed for the El Centro Naval Air Facility by El Centro staff based on actual operational data and were submitted by the District.

3.14 Mobile Source Forecasting

Table 3-6 summarizes the data and methods used to forecast future-year mobile source emissions by broad source category groupings.

Table 3-6. Growth Surrogates for Mobile Sources

Category	Growth Methodology
On-Road Sources	
All	Match total VMT projections provided by SCAG
Off-Road Gasoline Fueled Equipment	
Lawn & Garden	Household growth projection
Off-Road Equipment	Employment growth projection
Recreational Boats	Housing starts (short-term) and human population growth (long-term)
Recreational Vehicles	Housing starts (short-term) and human population growth (long-term)
Off-Road Diesel-Fueled Equipment	
Construction and Mining	California construction employment data from U.S. Bureau of Labor Statistics
Farm Equipment	2011 study of forecasted growth by URS Corp.
Industrial Equipment	California construction employment data from Bureau of Labor Statistics
Trains (line haul)	FAF 2015 growth projections and historical Bureau of Transportation Statistics locomotive fuel trends (1990-2013 data)
Transport Refrigeration Units	Projection of historical Truck/Trailer TRU sales from ACT Research, adjusted for recession.
Off-Road Equipment (Other Fuels)	
Military Aircraft	The growth for military aircraft are based on estimates from El Centro Naval Air Facility staff that facilitate the fielding of new weapons systems, potentially expanding operations that accommodate all activities necessary to continue the national security mission.

3.15 Condensable Particulate Matter

3.15.1 Background

Condensable PM is "material that is vapor phase at stack conditions, but which condenses and/or reacts upon cooling and dilution in the ambient air to form solid or liquid PM immediately after discharge from the stack."[19] Condensable PM is a component of primary PM, which is the sum of condensable and filterable PM. Filterable PM comprises "particles that are directly emitted by a source as a solid or liquid [aerosol] at stack or release conditions."[20] All condensable PM is assumed to be smaller than 2.5 microns (µm) in diameter; therefore, $PM_{2.5}$ primary is the sum of condensable PM and filterable PM less than 2.5 µm, while PM_{10} primary is the sum of condensable PM and filterable PM less than 10 µm.

The AERR requires states to report annual emissions of filterable and condensable components of $PM_{2.5}$ and PM_{10}, "as applicable," for large sources every inventory year and for all sources every third inventory year, beginning with 2011.[21] Subsequent emissions inventory guidance[22] from the USEPA clarifies the meaning of the phrase "as applicable" by providing a list of source types "for which condensable PM is expected by the AERR." These source types are stationary point and nonpoint combustion sources that are expected to generate condensable PM and include, for instance, commercial cooking, fuel combustion at electric generating utilities, industrial processes like cement or chemical manufacturing, and flares or incinerators associated with waste disposal. The District reports condensable PM from stationary and area sources using the methodology outlined below.

Mobile sources emit PM in both filterable and condensable form; however, the AERR does not require states to report filterable and condensable PM separately for mobile sources. Emissions from mobile sources are reported in the emissions inventory in Section 3.16 and Appendix B as primary PM, e.g. the sum of filterable and condensable PM.

3.15.2 Methodology

For the current inventory, the District has collected data on primary PM only, containing both filterable and condensable components without distinguishing between the two. Consequently, to be able to report emissions of the condensable component of $PM_{2.5}$ separately as required by the AERR, the District must use conversion factors to convert primary $PM_{2.5}$ to condensable PM.

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[19] 40 CFR §51.50
[20] Ibid.
[21] 40 CFR §51.15(a)(1) and §51.30(b)(1)
[22] USEPA. 2017. Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations. May. Available at: https://www.epa.gov/sites/production/files/2017-07/documents/ei_guidance_may_2017_final_rev.pdf. Accessed: March 2018.

USEPA has published an augmentation tool[23] which contains conversion factors for each source classification code (SCC) to convert filterable PM_{10} (PM10FIL) to condensable PM (PMCON). In this form, these conversion factors ($CF_{PM10FIL \rightarrow PMCON}$) are not useful because the District does not directly collect PM10FIL data. But, the following formula adjusts USEPA's existing conversion factors to obtain new conversion factors for each SCC that convert from primary PM_{10} (PM10PRI)—data which the District does collect—to condensable PM ($CF_{PM10PRI \rightarrow PMCON}$):

$$CF_{PM10PRI \rightarrow PMCON} = \frac{CF_{\mathrm{PM10FIL \rightarrow PMCON}}}{(1 + CF_{\mathrm{PM10FIL \rightarrow PMCON}})}$$

The formula was derived as follows:

$$PM10PRI = PM10FIL + PMCON$$

and

$$PMCON = PM10FIL\,(CF_{\mathrm{PM10FIL \rightarrow PMCON}})$$

and

$$PMCON = PM10PRI(CF_{\mathrm{PM10PRI \rightarrow PMCON}})$$

$$\therefore \quad PM10PRI = PM10FIL + PM10FIL\,(CF_{\mathrm{PM10FIL \rightarrow PMCON}}) = PM10FIL(1 + CF_{\mathrm{PM10FIL \rightarrow PMCON}})$$

and

$$CF_{\mathrm{PM10PRI \rightarrow PMCON}} = \frac{PMCON}{PM10PRI} = \frac{PMCON}{PM10FIL(1 + CF_{\mathrm{PM10FIL \rightarrow PMCON}})}$$

$$= \frac{PM10FIL\,(CF_{\mathrm{PM10FIL \rightarrow PMCON}})}{PM10FIL(1 + CF_{\mathrm{PM10FIL \rightarrow PMCON}})} = \frac{CF_{\mathrm{PM10FIL \rightarrow PMCON}}}{(1 + CF_{\mathrm{PM10FIL \rightarrow PMCON}})}$$

Since condensable PM is typically smaller than 2.5µm, a 1:1 ratio between PM_{10} and $PM_{2.5}$ may be assumed, and the same conversion factors can likewise be applied to convert primary $PM_{2.5}$ (PM25PRI) to condensable PM using the same method. That is, $CF_{PM10PRI \rightarrow PMCON} = CF_{PM25PRI \rightarrow PMCON}$ where $CF_{PM25PRI \rightarrow PMCON}$ represents the conversion factors that convert from primary $PM_{2.5}$—again, data the District does collect—to condensable PM.

These calculated conversion factors ($CF_{PM25PRI \rightarrow PMCON}$), derived from the USEPA conversion factors and presented in Table 3-7 below, are used to determine the condensable PM component of primary $PM_{2.5}$ for applicable source types located in the District (see Section 3.16 and Appendix B).

[23] USEPA. 2016. PM Augmentation. Air Emissions Inventories. May 20. Available at: https://www.epa.gov/air-emissions-inventories/pm-augmentation. Accessed: March 2018.

Table 3-7. Calculated Primary $PM_{2.5}$ to Condensable $PM_{2.5}$ Conversion Factors

Source Classification Code	Source Classification Code Description				$PM_{2.5}$ to $PM_{condensable}$ Conversion Factor
	First Digit	First 3 Digits	First 6 Digits	First 8 Digits	
10100601	External Combustion Boiler	Electricity Generation	Natural Gas	>100 MMBtu/hr	0.6154
10200601	External Combustion Boiler	Industrial	Natural Gas	>100 MMBtu/hr	0.6154
10200604	External Combustion Boiler	Industrial	Natural Gas	Cogeneration	0.6154
10300603	External Combustion Boiler	Commercial/Institutional	Natural Gas	<10 MMBtu/hr	0.6154
20100102	Internal Combustion	Electricity Generation	Distillate Oil/Diesel	Reciprocating	0.0703
20100201	Internal Combustion	Electricity Generation	Natural Gas	Turbine	0.4505
20100301	Internal Combustion	Electricity Generation	Diesel	Reciprocating	0.4505
20300301	Internal Combustion	Commercial/Institutional	Gasoline	Reciprocating	0.0672
30200104	Food/Agriculture	Alfalfa Dehydration	Pellet Cooler	Cyclone	0.1311
30200199	Food/Agriculture	Alfalfa Dehydration	Not Classified	Other	0
30200832	Food/Agriculture	Feed Manufacture	Other Grain Feed	Handling & Transferring	0
30201412	Food/Agriculture	Starch Manufacture	Combined Operations	Unmodified Flash Dryers	0.4004
30203801	Food/Agriculture	Animal/Poultry	Rendering	General	0
30500201	Petroleum Industry	Asphalt Concrete	Rotary Dryer	Conventional Plant	0.1660
30500204	Petroleum Industry	Asphalt Concrete	Cold Aggregate Handling	--	0
30500205	Petroleum Industry	Asphalt Concrete	Drum Dryer	Hot Asphalt Plant	0
30501106	Mineral Products	Concrete Batching	Sand/Aggregate	Transfer to Bins	0
30501603	Mineral Products	Lime Manufacture	Calcining	Vertical Kiln	0.2304
30502503	Mining Operations	Nonmetallic Mineral	Sand/Gravel	Transfer Station	0
39000889	Industrial Process	Industrial Process Fuel	Coke	Not Classified	0
2302002100[a]	Cooking	Commercial	Charbroiling	--	0.9968

Notes:

[a] USEPA developed a separate augmentation tool specifically for commercial cooking, containing updated conversion factors from PM25PRI to PMCON for four commercial cooking source types.

3.16 Emission Inventories

Tables 3-8a through 3-11b present the 2012, 2019, 2021, and 2022 direct (or primary) $PM_{2.5}$, condensable $PM_{2.5}$, filterable $PM_{2.5}$, and $PM_{2.5}$ precursors annual emission inventories (averaged to the day) for the Imperial County $PM_{2.5}$ Nonattainment Area by major source category. These inventories were developed from CARB's CEPAM, Version 1.05, which utilizes the data and methodologies outlined in Sections 3.1 through 3.14. More detailed inventories are provided in Appendix B.

Figure 3-1 shows the trends in primary $PM_{2.5}$ emissions during these key years. Imperial County primary $PM_{2.5}$ emissions show modest reductions between the base year (2012) and 2022. Appendix A discusses these emissions in the context of the greater regional emissions, including those from sources in Mexicali, Mexico.

Figure 3-1. Trends in Primary $PM_{2.5}$ Annual Emissions for the Imperial County $PM_{2.5}$ Nonattainment Area

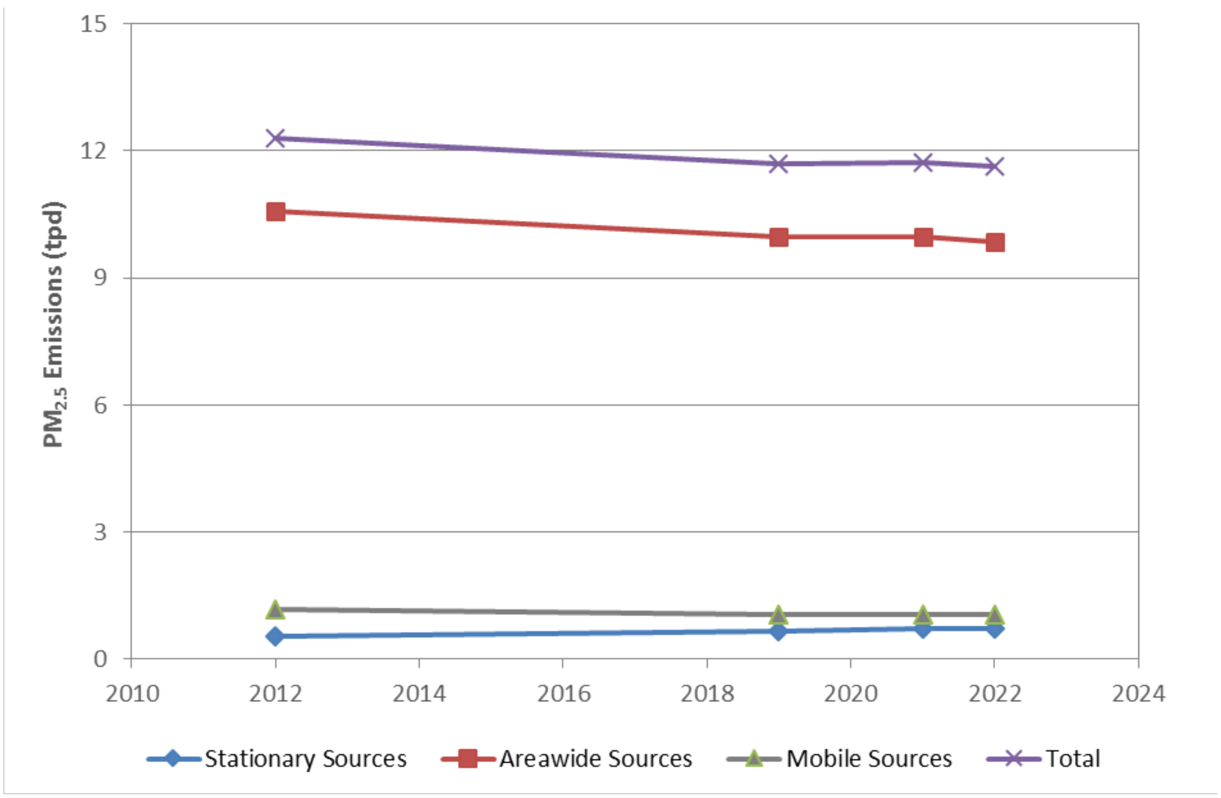


Table 3-8a. Direct $PM_{2.5}$ and $PM_{2.5}$ Precursor Emissions by Major Source Category in the Imperial County $PM_{2.5}$ Nonattainment Area, 2012 (Annual)

Source Category	$PM_{2.5}$ (tons/day)	% Total	NH_3 (tons/day)	% Total	NO_X (tons/day)	% Total	SO_X (tons/day)	% Total	ROG (tons/day)	% Total
Stationary Sources										
Fuel Combustion	0.13	1.08%	0.00	0.00%	1.52	10.71%	0.00	1.74%	0.05	0.44%
Waste Disposal	0.00	0.00%	1.19	5.13%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Cleaning and Surface Coatings	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.41	3.44%
Petroleum Production and Marketing	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.50	4.17%
Industrial Processes	0.41	3.37%	0.00	0.00%	0.02	0.15%	0.00	0.00%	0.00	0.01%
Total Stationary Sources	**0.55**	**4.45%**	**1.19**	**5.13%**	**1.54**	**10.85%**	**0.00**	**1.74%**	**0.96**	**8.06%**
Areawide Sources										
Solvent Evaporation	0.00	0.00%	12.87	55.37%	0.00	0.00%	0.00	0.00%	3.01	25.35%
Farming Operations	0.91	7.36%	8.68	37.34%	0.00	0.00%	0.00	0.00%	1.48	12.47%
Unpaved Road Dust	4.76	38.73%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Fugitive Windblown Dust	3.69	30.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Managed Burning and Disposal	0.82	6.70%	0.13	0.54%	0.29	2.05%	0.05	18.11%	0.60	5.04%
Other Processes	0.40	3.21%	0.26	1.13%	0.08	0.56%	0.00	0.74%	0.04	0.36%
Total Areawide Sources	**10.58**	**86.01%**	**21.94**	**94.37%**	**0.37**	**2.62%**	**0.05**	**18.86%**	**5.14**	**43.22%**
Mobile Sources										
On-Road Vehicles	0.19	1.55%	0.11	0.49%	5.31	37.38%	0.02	5.85%	1.77	14.86%
Off-Road Vehicles	0.98	7.99%	0.00	0.01%	6.98	49.15%	0.21	73.56%	4.03	33.86%
Total Mobile Sources	**1.17**	**9.54%**	**0.12**	**0.50%**	**12.28**	**86.53%**	**0.22**	**79.40%**	**5.79**	**48.71%**
Total for Imperial County	**12.30**	**100%**	**23.24**	**100%**	**14.19**	**100%**	**0.28**	**100%**	**11.89**	**100%**

Notes:
Emissions for Imperial County were queried from the California Emissions Projection Analysis Model (CEPAM), Version 1.05.
Totals may not add up due to rounding.

Table 3-8b. Condensable and Filterable $PM_{2.5}$ Emissions by Major Source Category in the Imperial County $PM_{2.5}$ Nonattainment Area, 2012 (Annual)

Source Category	Total $PM_{2.5}$ (tons/day)	Condensable $PM_{2.5}$ (tons/day)	Filterable $PM_{2.5}$ (tons/day)
Stationary Sources			
Fuel Combustion	0.133	0.030	0.103
Waste Disposal	0	0	0
Cleaning and Surface Coatings	0	0	0
Petroleum Production and Marketing	0	0	0
Industrial Processes	0.415	0.009	0.406
Total Stationary Sources	**0.548**	**0.039**	**0.509**
Areawide Sources			
Solvent Evaporation	0	0	0
Farming Operations	0.906	0	0.906
Unpaved Road Dust	4.762	0	4.762
Fugitive Windblown Dust	3.689	0	3.689
Managed Burning and Disposal	0.824	0	0.824
Other Processes	0.395	0.056	0.340
Total Areawide Sources	**10.576**	**0.056**	**10.520**
Mobile Sources			
On-Road Vehicles	0.191	--	--
Off-Road Vehicles	0.982	--	--
Total Mobile Sources	**1.173**	--	--
Total for Imperial County	**12.297**	**--**	**--**

Notes:
Totals may not add up due to rounding.
"--" indicates that the portion of condensable/filterable $PM_{2.5}$ is unknown or unmeasurable.

Table 3-9a. Direct $PM_{2.5}$ and $PM_{2.5}$ Precursor Emissions by Major Source Category in the Imperial County $PM_{2.5}$ Nonattainment Area, 2019 (Annual)

Source Category	$PM_{2.5}$ (tons/day)	% Total	NH_3 (tons/day)	% Total	NO_X (tons/day)	% Total	SO_X (tons/day)	% Total	ROG (tons/day)	% Total
Stationary Sources										
Fuel Combustion	0.11	0.97%	0.00	0.00%	1.33	13.03%	0.00	1.65%	0.04	0.40%
Waste Disposal	0.00	0.00%	1.21	5.39%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Cleaning and Surface Coatings	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.49	4.56%
Petroleum Production and Marketing	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.45	4.15%
Industrial Processes	0.55	4.71%	0.00	0.00%	0.02	0.22%	0.00	0.00%	0.00	0.02%
Total Stationary Sources	**0.66**	**5.68%**	**1.21**	**5.39%**	**1.35**	**13.24%**	**0.00**	**1.65%**	**0.98**	**9.13%**
Areawide Sources										
Solvent Evaporation	0.00	0.00%	12.00	53.68%	0.00	0.00%	0.00	0.00%	2.93	27.17%
Farming Operations	0.85	7.31%	8.60	38.49%	0.00	0.00%	0.00	0.00%	1.47	13.64%
Unpaved Road Dust	4.18	35.74%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Fugitive Windblown Dust	3.69	31.54%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Managed Burning and Disposal	0.72	6.18%	0.11	0.49%	0.26	2.50%	0.04	15.02%	0.53	4.88%
Other Processes	0.53	4.56%	0.33	1.49%	0.07	0.69%	0.00	0.81%	0.05	0.42%
Total Areawide Sources	**9.97**	**85.32%**	**21.05**	**94.15%**	**0.33**	**3.19%**	**0.05**	**15.83%**	**4.97**	**46.11%**
Mobile Sources										
On-Road Vehicles	0.09	0.80%	0.10	0.45%	2.86	28.03%	0.02	5.91%	1.17	10.83%
Off-Road Vehicles	0.96	8.20%	0.00	0.01%	5.67	55.54%	0.23	76.61%	3.65	33.93%
Total Mobile Sources	**1.05**	**9.00%**	**0.10**	**0.46%**	**8.54**	**83.57%**	**0.25**	**82.53%**	**4.82**	**44.76%**
Total for Imperial County	**11.69**	**100%**	**22.35**	**100%**	**10.22**	**100%**	**0.30**	**100%**	**10.77**	**100%**

Notes:
Emissions for Imperial County were queried from the California Emissions Projection Analysis Model (CEPAM), Version 1.05.
Totals may not add up due to rounding.

Table 3-9b. Condensable and Filterable $PM_{2.5}$ Emissions by Major Source Category in the Imperial County $PM_{2.5}$ Nonattainment Area, 2019 (Annual)

Source Category	Total $PM_{2.5}$ (tons/day)	Condensable $PM_{2.5}$ (tons/day)	Filterable $PM_{2.5}$ (tons/day)
Stationary Sources			
Fuel Combustion	0.114	0.024	0.089
Waste Disposal	0	0	0
Cleaning and Surface Coatings	0	0	0
Petroleum Production and Marketing	0	0	0
Industrial Processes	0.551	0.010	0.541
Total Stationary Sources	**0.664**	**0.034**	**0.630**
Areawide Sources			
Solvent Evaporation	0	0	0
Farming Operations	0.854	0	0.854
Unpaved Road Dust	4.177	0	4.177
Fugitive Windblown Dust	3.686	0	3.686
Managed Burning and Disposal	0.722	0	0.722
Other Processes	0.533	0.070	0.463
Total Areawide Sources	**9.972**	**0.070**	**9.901**
Mobile Sources			
On-Road Vehicles	0.093	--	--
Off-Road Vehicles	0.958	--	--
Total Mobile Sources	**1.052**	--	--
Total for Imperial County	**11.687**	**--**	**--**

Notes:

Totals may not add up due to rounding.

"--" indicates that the portion of condensable/filterable $PM_{2.5}$ is unknown or unmeasurable.

Table 3-10a. Direct $PM_{2.5}$ and $PM_{2.5}$ Precursor Emissions by Major Source Category in the Imperial County $PM_{2.5}$ Nonattainment Area, 2021 (Annual)

Source Category	$PM_{2.5}$ (tons/day)	% Total	NH_3 (tons/day)	% Total	NO_X (tons/day)	% Total	SO_X (tons/day)	% Total	ROG (tons/day)	% Total
Stationary Sources										
Fuel Combustion	0.12	1.03%	0.00	0.00%	1.42	14.85%	0.01	1.78%	0.05	0.42%
Waste Disposal	0.00	0.00%	1.21	5.45%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Cleaning and Surface Coatings	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.51	4.77%
Petroleum Production and Marketing	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.43	4.01%
Industrial Processes	0.59	5.00%	0.00	0.00%	0.02	0.24%	0.00	0.00%	0.00	0.02%
Total Stationary Sources	**0.71**	**6.03%**	**1.21**	**5.45%**	**1.45**	**15.09%**	**0.01**	**1.78%**	**0.98**	**9.22%**
Areawide Sources										
Solvent Evaporation	0.00	0.00%	11.82	53.27%	0.00	0.00%	0.00	0.00%	2.97	27.89%
Farming Operations	0.84	7.19%	8.60	38.78%	0.00	0.00%	0.00	0.00%	1.47	13.78%
Unpaved Road Dust	4.17	35.58%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Fugitive Windblown Dust	3.68	31.41%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Managed Burning and Disposal	0.71	6.05%	0.11	0.49%	0.25	2.62%	0.04	14.76%	0.52	4.84%
Other Processes	0.56	4.76%	0.35	1.56%	0.07	0.74%	0.00	0.84%	0.05	0.43%
Total Areawide Sources	**9.97**	**84.99%**	**20.88**	**94.10%**	**0.32**	**3.36%**	**0.05**	**15.60%**	**5.01**	**46.94%**
Mobile Sources										
On-Road Vehicles	0.09	0.79%	0.10	0.44%	2.56	26.73%	0.02	5.99%	1.08	10.09%
Off-Road Vehicles	0.96	8.19%	0.00	0.01%	5.26	54.83%	0.23	76.63%	3.60	33.76%
Total Mobile Sources	**1.05**	**8.98%**	**0.10**	**0.45%**	**7.82**	**81.55%**	**0.25**	**82.62%**	**4.68**	**43.85%**
Total for Imperial County	**11.73**	**100%**	**22.19**	**100%**	**9.59**	**100%**	**0.30**	**100%**	**10.67**	**100%**

Notes:
Emissions for Imperial County were queried from the California Emissions Projection Analysis Model (CEPAM), Version 1.05.
Totals may not add up due to rounding.

Table 3-10b. Condensable and Filterable $PM_{2.5}$ Emissions by Major Source Category in the Imperial County $PM_{2.5}$ Nonattainment Area, 2021 (Annual)

Source Category	Total $PM_{2.5}$ (tons/day)	Condensable $PM_{2.5}$ (tons/day)	Filterable $PM_{2.5}$ (tons/day)
Stationary Sources			
Fuel Combustion	0.121	0.025	0.096
Waste Disposal	0	0	0
Cleaning and Surface Coatings	0	0	0
Petroleum Production and Marketing	0	0	0
Industrial Processes	0.586	0.010	0.576
Total Stationary Sources	**0.707**	**0.035**	**0.672**
Areawide Sources			
Solvent Evaporation	0	0	0
Farming Operations	0.844	0	0.844
Unpaved Road Dust	4.175	0	4.175
Fugitive Windblown Dust	3.685	0	3.685
Managed Burning and Disposal	0.710	0	0.710
Other Processes	0.559	0.073	0.485
Total Areawide Sources	**9.972**	**0.073**	**9.899**
Mobile Sources			
On-Road Vehicles	0.093	--	--
Off-Road Vehicles	0.961	--	--
Total Mobile Sources	**1.053**	--	--
Total for Imperial County	**11.733**	**--**	**--**

Notes:
Totals may not add up due to rounding.
"--" indicates that the portion of condensable/filterable $PM_{2.5}$ is unknown or unmeasurable.

Table 3-11a. Direct $PM_{2.5}$ and $PM_{2.5}$ Precursor Emissions by Major Source Category in the Imperial County $PM_{2.5}$ Nonattainment Area, 2022 (Annual)

Source Category	$PM_{2.5}$ (tons/day)	% Total	NH_3 (tons/day)	% Total	NO_X (tons/day)	% Total	SO_X (tons/day)	% Total	ROG (tons/day)	% Total
Stationary Sources										
Fuel Combustion	0.12	1.04%	0.00	0.00%	1.42	15.47%	0.01	1.78%	0.05	0.42%
Waste Disposal	0.00	0.00%	1.21	5.46%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Cleaning and Surface Coatings	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.52	4.90%
Petroleum Production and Marketing	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.42	3.90%
Industrial Processes	0.60	5.18%	0.00	0.00%	0.02	0.25%	0.00	0.00%	0.00	0.02%
Total Stationary Sources	**0.72**	**6.23%**	**1.21**	**5.46%**	**1.45**	**15.72%**	**0.01**	**1.78%**	**0.99**	**9.25%**
Areawide Sources										
Solvent Evaporation	0.00	0.00%	11.76	53.13%	0.00	0.00%	0.00	0.00%	2.99	28.00%
Farming Operations	0.84	7.22%	8.60	38.87%	0.00	0.00%	0.00	0.00%	1.47	13.77%
Unpaved Road Dust	4.05	34.78%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Fugitive Windblown Dust	3.68	31.68%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Managed Burning and Disposal	0.71	6.07%	0.11	0.48%	0.25	2.71%	0.04	14.68%	0.51	4.81%
Other Processes	0.57	4.94%	0.35	1.58%	0.07	0.77%	0.00	0.84%	0.05	0.43%
Total Areawide Sources	**9.85**	**84.68%**	**20.82**	**94.07%**	**0.32**	**3.48%**	**0.05**	**15.52%**	**5.02**	**47.00%**
Mobile Sources										
On-Road Vehicles	0.10	0.83%	0.10	0.46%	2.41	26.18%	0.02	6.15%	1.08	10.15%
Off-Road Vehicles	0.96	8.26%	0.00	0.01%	5.03	54.62%	0.23	76.55%	3.59	33.61%
Total Mobile Sources	**1.06**	**9.09%**	**0.10**	**0.47%**	**7.44**	**80.80%**	**0.25**	**82.70%**	**4.67**	**43.75%**
Total for Imperial County	**11.63**	**100%**	**22.14**	**100%**	**9.21**	**100%**	**0.30**	**100%**	**10.67**	**100%**

Notes:
Emissions for Imperial County were queried from the California Emissions Projection Analysis Model (CEPAM), Version 1.05.
Totals may not add up due to rounding.

Table 3-11b. Condensable and Filterable $PM_{2.5}$ Emissions by Major Source Category in the Imperial County $PM_{2.5}$ Nonattainment Area, 2022 (Annual)

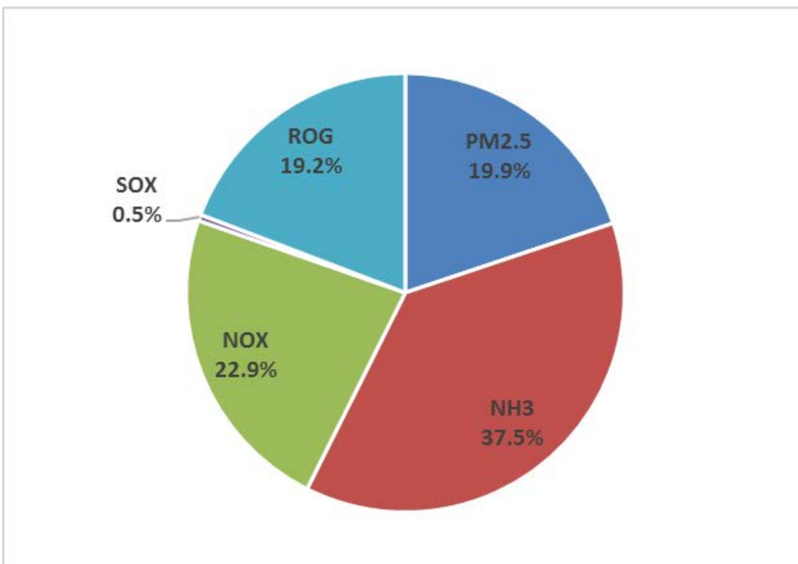
Source Category	Total $PM_{2.5}$ (tons/day)	Condensable $PM_{2.5}$ (tons/day)	Filterable $PM_{2.5}$ (tons/day)
Stationary Sources			
Fuel Combustion	0.121	0.026	0.096
Waste Disposal	0	0	0
Cleaning and Surface Coatings	0	0	0
Petroleum Production and Marketing	0	0	0
Industrial Processes	0.603	0.010	0.593
Total Stationary Sources	**0.725**	**0.036**	**0.689**
Areawide Sources			
Solvent Evaporation	0	0	0
Farming Operations	0.840	0	0.840
Unpaved Road Dust	4.046	0	4.046
Fugitive Windblown Dust	3.685	0	3.685
Managed Burning and Disposal	0.706	0	0.706
Other Processes	0.574	0.074	0.500
Total Areawide Sources	**9.850**	**0.074**	**9.776**
Mobile Sources			
On-Road Vehicles	0.096	--	--
Off-Road Vehicles	0.961	--	--
Total Mobile Sources	**1.057**	--	--
Total for Imperial County	**11.632**	**--**	**--**

Notes:
Totals may not add up due to rounding.
"--" indicates that the portion of condensable/filterable $PM_{2.5}$ is unknown or unmeasurable.

3.17 Evaluation of Significant Precursors

In addition to direct emissions, particulate matter is formed in the atmosphere from precursors. SO_X, NO_X, VOCs, and NH_3 all contribute to the formation of particulate matter. For this Annual $PM_{2.5}$ SIP, CARB staff evaluated $PM_{2.5}$ precursors consistent with the 2016 $PM_{2.5}$ NAAQS Implementation Final Rule ("2016 $PM_{2.5}$ Implementation Rule").[24] Specifically, CARB staff developed a technical demonstration indicating whether emissions of a particular precursor significantly contribute to $PM_{2.5}$ levels in the Imperial County $PM_{2.5}$ Nonattainment Area. USEPA's Draft $PM_{2.5}$ Precursor Demonstration Guidance[25] document states that a precursor may be excluded from control requirements if the analysis shows that the air quality contribution of the precursor to $PM_{2.5}$ does not exceed the recommended contribution threshold of 0.2 $\mu g/m^3$ for the annual $PM_{2.5}$ standard. The 2016 $PM_{2.5}$ Implementation Rule recommends evaluating chemical speciation data and emissions inventories. In the case of Calexico, evaluation of the relative contributions to the emission inventories does not appropriately characterize main contributors to the $PM_{2.5}$ problem. As illustrated in Figure 3-2, emissions of directly emitted $PM_{2.5}$ are lower than emissions of NH_3 and NO_X (detailed inventory numbers are provided in Section 3.16).

Figure 3-2. Composition of 2012 Imperial County $PM_{2.5}$ Nonattainment Area Baseline Emissions (Annual)



The emission inventory suggests that $PM_{2.5}$ precursors, particularly ROG, NO_X, and NH_3 are important contributors to the total emissions; however, chemical composition data indicates otherwise. Figure 3-2, for example, shows that more than three quarters of the emissions are from

[24] USEPA. 2016. *Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements; Final Rule.* Federal Register. Vol. 81. No. 164. August 24, 2016. p. 58010.

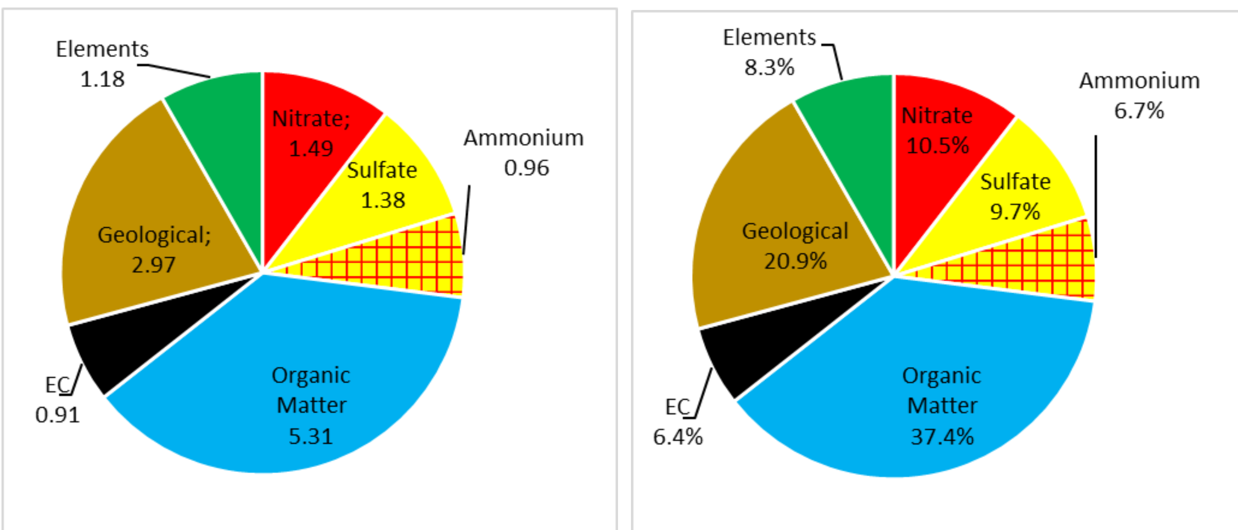
[25] USEPA. 2016. Draft $PM_{2.5}$ Precursor Demonstration Guidance. EPA-454/P-16-001. November. Available at: https://www.epa.gov/sites/production/files/2016-11/documents/transmittal_memo_and_draft_pm25_precursor_demo_guidance_11_17_16.pdf. Accessed: January 2018.

precursors, but chemical composition data illustrated in Figure 3-3 indicates that 27 percent of the mass is from secondary formation and the remaining 73 percent is from direct $PM_{2.5}$ emissions. This apparent inconsistency is the result of meteorological conditions which favor accumulation of direct $PM_{2.5}$ over secondary aerosol formation.

3.17.1 Concentration-Based Contribution Analysis

Chemical speciation data for 2015-2016 was utilized to demonstrate contribution of individual precursors to the 2014 modeled design value of 14.2 µg/m^3. Figure 3-3 shows the average chemical composition at Calexico in the 2015-2016 time period. As discussed previously, directly emitted $PM_{2.5}$ (organic matter, elemental carbon, geological material, and elements) contributes 73 percent of the $PM_{2.5}$ mass.

Figure 3-3. 2015-2016 Annual Average Composition (Micrograms per Cubic Meter) and Percentage to $PM_{2.5}$ Mass



The Draft $PM_{2.5}$ Precursor Demonstration Guidance[26] provides a brief discussion of precursor formation which is summarized below.

SO_X

Since sulfate can exist in the atmosphere in the form of sulfuric acid if it is not neutralized by ammonia, the SO_X contribution to the $PM_{2.5}$ design value is evaluated by estimating the sulfate contribution to the design value. Sulfate contributes 1.38 µg/m^3 or 9.7 percent of the modeled $PM_{2.5}$ annual design value.

[26] Ibid.

NO_X

Since the nitrate ion cannot exist in the atmosphere as a particle without being neutralized by ammonia the ammonium portion of ammonium nitrate should be counted toward the NO_X contribution to the $PM_{2.5}$ mass. NO_X contributes directly to ammonium nitrate formation. Its impact on the $PM_{2.5}$ design value was evaluated by estimating the ammonium nitrate contribution. Ammonium nitrate contributes 2.45 µg/m^3 or about 17.3 percent to the modeled $PM_{2.5}$ annual design value.

Ammonia

As mentioned above, the default recommendation for assigning $PM_{2.5}$ precursors to $PM_{2.5}$ species is to associate all measured ammonium to ammonia as well as all of the nitrate ion mass. As a result, the ammonia contribution to the $PM_{2.5}$ design value is calculated from all measured ammonium plus the nitrate ion. The two components together contribute 2.45 µg/m^3 or about 17.3 percent to the modeled $PM_{2.5}$ annual design value.

VOC

There are two routes by which VOC can contribute to ambient $PM_{2.5}$. The first is through various chemical reactions leading to the formation of Secondary Organic Aerosols (SOAs). The second is through photochemical reactions that create oxidants such as ozone and hydroxyl radicals, which in turn oxidize NO_X emissions leading to the formation of particulate ammonium nitrate. If there is any contribution of SOAs to ambient $PM_{2.5}$ levels, it would be primarily from biogenic emissions and mainly formed during summer when temperatures are warmer and concentrations are lowest. Man-made sources of SOA precursors include solvents, catalyst gasoline engines, wood smoke, and non-catalytic gasoline engines. Due to the lack of SOA data specific to Calexico, the precursor significance analysis completed in the modeling was used to determine significance. The analysis showed that a 70 percent reduction in VOC emissions in the Imperial County $PM_{2.5}$ Nonattainment Area reduced the design value by 0.03 µg/m^3, substantially lower than the level of significance suggested by USEPA (0.2 µg/m^3).

Table 3-12 below is an overview of the percent that each precursor pollutant contributes to the total emission inventory and average speciation for $PM_{2.5}$ and all precursors in the Imperial County $PM_{2.5}$ Nonattainment Area. The percent contribution for each species is then applied to the modeling design value in 2014 to determine if the precursor exceeds the significance threshold that the USEPA has recommended.

Table 3-12. Precursor Contribution and Relation to the Modeling Design Value

$PM_{2.5}$ Precursors	Emissions %	Speciation %	Contribution to Modeling Design Value in 2014 (14.2 µg/m^3)
SO_X	0.5%	9.7%	1.38 µg/m^3
NO_X	22.9%	17.3%	2.45 µg/m^3
Ammonia	37.5%	17.3%	2.45 µg/m^3

This comprehensive analysis of emissions and precursor contribution demonstrates that SO_X, NO_X, and ammonia are significant at Calexico when compared with directly emitted $PM_{2.5}$. For this reason, a sensitivity-based contribution analysis via modeling was done to further explore whether a reduction in these precursors would have an impact on Calexico's design value and attainment.

3.17.2 Modeling-Based Precursor Sensitivity Analysis

To evaluate the impact of reducing emissions of different $PM_{2.5}$ precursors on the base year $PM_{2.5}$ design values, a series of model sensitivity simulations were conducted, where emissions of the precursor species in Imperial County were reduced by 70% from the base year (2012) emissions. The 70% level was chosen as the high end of the recommended range of reductions by the USEPA. Mexico emissions were included in the simulations, but were not reduced as part of the sensitivity analysis. Specifically, the effect of reductions in the following $PM_{2.5}$ precursors was investigated: direct $PM_{2.5}$ (or primary $PM_{2.5}$), NO_X, SO_X, NH_3, and VOCs. For each precursor, only anthropogenic emissions in Imperial County were adjusted. Natural emissions and emissions outside of Imperial County (e.g., Mexico, other counties in California) were not changed.

Table 3-13 shows the change in base year design value at each site from a 70% reduction of controllable direct $PM_{2.5}$, NO_X, VOCs, SO_X, and NH_3 emissions. The design value change is calculated as the difference in the projected base year design value from the 70% reduction case minus the base year design value with Mexico emissions from Table 11 in the Modeling Assessment (Appendix D to Appendix A). As shown in Table 3-13, direct $PM_{2.5}$ reductions had the largest impact on the design value, with all sites exhibiting a reduction in design value greater than 1.8 $\mu g/m^3$. All $PM_{2.5}$ precursors exhibited a much smaller response, with the largest change being a 0.06 $\mu g/m^3$ decrease in design value at the Brawley monitors due to NO_x reductions. USEPA precursor sensitivity guidance defines a precursor to be insignificant if the annual design value change is less than 0.2 $\mu g/m^3$ when that precursor is reduced by 30-70%. Based on this definition, all $PM_{2.5}$ precursors are considered insignificant.

Given that a 70% perturbation in the emissions could be considered excessive, an additional sensitivity simulation for direct $PM_{2.5}$ was conducted, where emissions were reduced by 30%. When direct $PM_{2.5}$ emissions in Imperial County were reduced by 30%, the design value was reduced by 1.1 $\mu g/m^3$, 1.0 $\mu g/m^3$, and 0.8 $\mu g/m^3$ at the Calexico, El Centro, and Brawley monitors, respectively. Therefore, even with a much smaller 30% reduction, direct $PM_{2.5}$ is still deemed as not insignificant.

Table 3-13. Change of Base Year (2012) Design Value at Sites in Imperial County due to County Wide 70% Reduction of Anthropogenic Precursors[1,2]

Site	DV2012 (µg/m³)	DV2012 (µg/m³) with 70% reduction of anthropogenic precursor				
		$PM_{2.5}$	NO_X	ROG	SO_X	NH_3
Calexico	14.23	11.55	14.18	14.2	14.23	14.22
		-2.68	-0.05	-0.03	0	-0.01
El Centro	7.26	4.94	7.24	7.24	7.26	7.26
		-2.32	-0.02	-0.02	0	0
Brawley	7.38	5.53	7.32	7.36	7.38	7.37
		-1.85	-0.06	-0.02	0	-0.01

Notes:

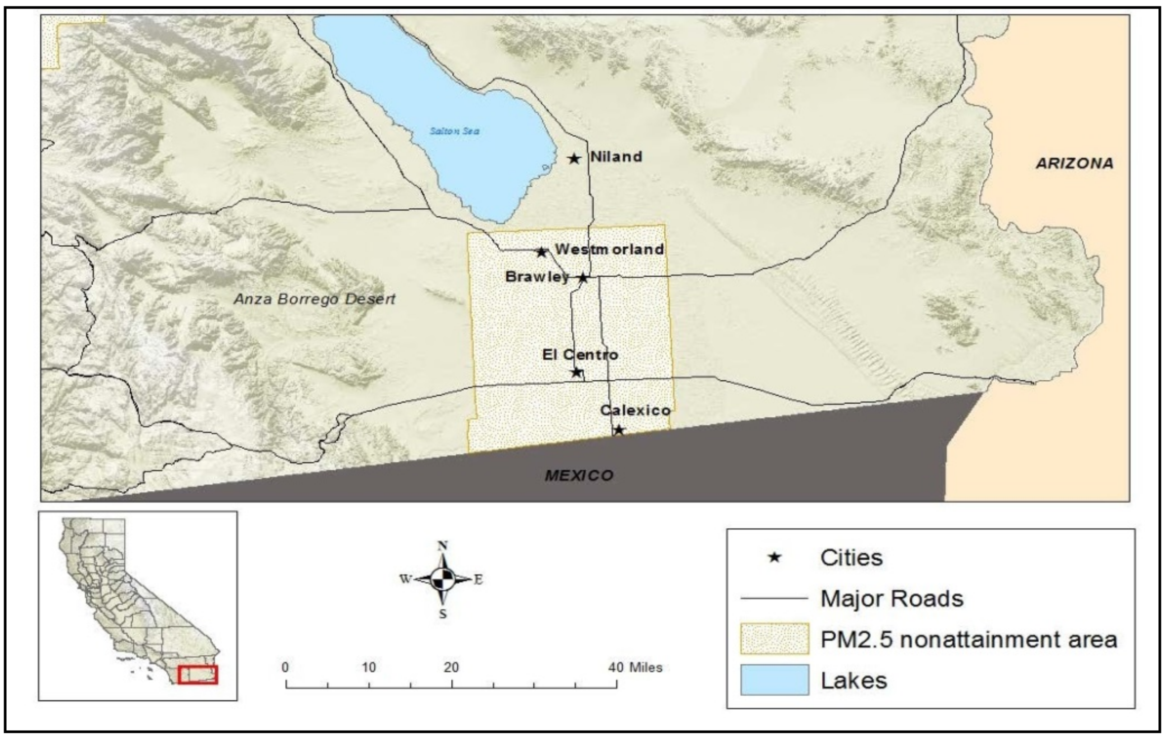
[1] Numbers in shaded rows are the reduction of design values (µg/m³) due to precursor reductions respectively.

[2] To highlight the differences, 2 decimal points in the design value are shown, rather than the single decimal point required by the SIP guidance.

4 Attainment Demonstration

On December 18, 2014, the USEPA designated the Imperial County $PM_{2.5}$ Nonattainment Area as nonattainment for the 12 μg/m^3 annual $PM_{2.5}$ standard based on air quality data collected adjacent to the Mexico international border. The Imperial County $PM_{2.5}$ Nonattainment Area is located in the southeast corner of California, which shares its southern border with Mexicali, Mexico (Figure 4-1). The Imperial County $PM_{2.5}$ Nonattainment Area includes three $PM_{2.5}$ monitoring sites, located in the cities of Calexico, El Centro, and Brawley (south to north). These three cities are about the same size and, in general, have similar emission sources. In theory, these $PM_{2.5}$ monitors should record similar $PM_{2.5}$ levels. Calexico is the only violating $PM_{2.5}$ monitor in the Imperial County $PM_{2.5}$ Nonattainment Area, with a $PM_{2.5}$ design value almost twice that of the other two monitors.

Figure 4-1. Imperial County PM2.5 Nonattainment Area



Measured $PM_{2.5}$ concentrations at sites in the Imperial County $PM_{2.5}$ Nonattainment Area may be attributed to emissions originating from one or more of the following sources: emissions generated locally within Imperial County, emissions generated outside the U.S. and transported across the international border, and emissions generated in the U.S. and transported within California or across state lines. From an air quality perspective, Calexico and the Mexicali Metropolitan Area share a common air shed. Since the topography does not restrict air flow from either side of the border and both areas experience similar meteorology, emissions from Mexicali can impact $PM_{2.5}$ levels in Calexico. The Calexico site is less than one mile from the international border and, applying USEPA monitor siting criteria, is representative of air pollution from Calexico and Mexicali.

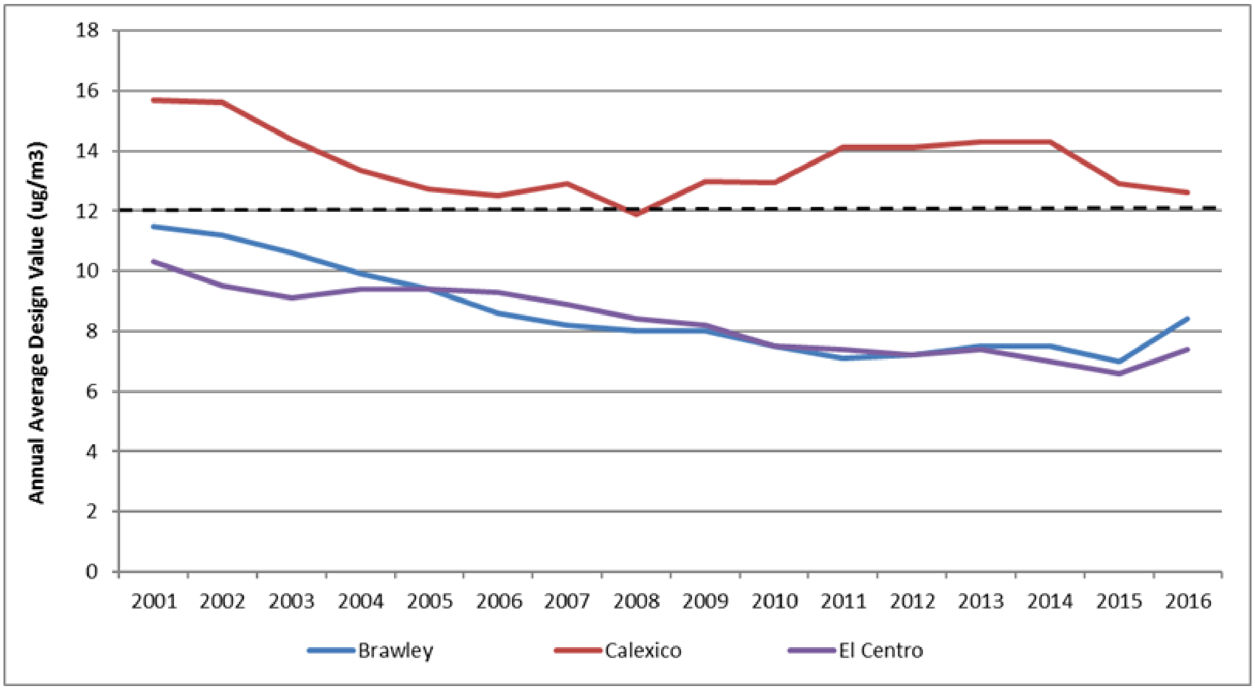
The Mexicali Metropolitan Area has a population of close to 1,000,000 people as compared to the significantly smaller city of Calexico which has a population of 38,572 people (2010 U.S. Census). Figure 4-2 shows a night-time aerial view of Calexico and Mexicali which highlights the large difference in size and population. Because of these differences, Mexicali emission sources on a daily basis can impact Calexico ambient $PM_{2.5}$ concentrations. Emission inventory data for Mexicali shows that Mexicali emissions are magnitudes higher than the emissions in the Imperial County $PM_{2.5}$ Nonattainment Area.

Figure 4-2. Mexicali and Calexico

With the exception of the border area represented by the Calexico monitor, time series plots of air quality data in the Imperial County $PM_{2.5}$ Nonattainment Area generally show improvement over the last 18 years. The trend in annual design values for Calexico, El Centro, and Brawley illustrate the extent to which the Brawley and El Centro annual average design values track over time, while design values for Calexico over the same period differ in both magnitude and direction (Figure 4-3). Figure 4-3 below demonstrates that the Imperial County $PM_{2.5}$ Nonattainment Area is nearing the level of the annual standard and exceeds the annual $PM_{2.5}$ standard by 5 percent.

Technical analyses conducted for the Imperial County SIP for the 24-hour $PM_{2.5}$ standard support the supposition that stagnant meteorological conditions impede dispersion and facilitate the build-up of $PM_{2.5}$ concentrations in the Calexico-Mexicali air shed, particularly during the winter months of November through January.[27] These meteorological conditions, coupled with emissions of local and international origin, impact the area's annual design value as well. While Brawley and El Centro have responded similarly to California's emission control programs with a resulting improvement in air quality, Calexico's $PM_{2.5}$ air quality remains above the standard.

Figure 4-3. 2001-2016 Annual Average PM2.5 Design Values



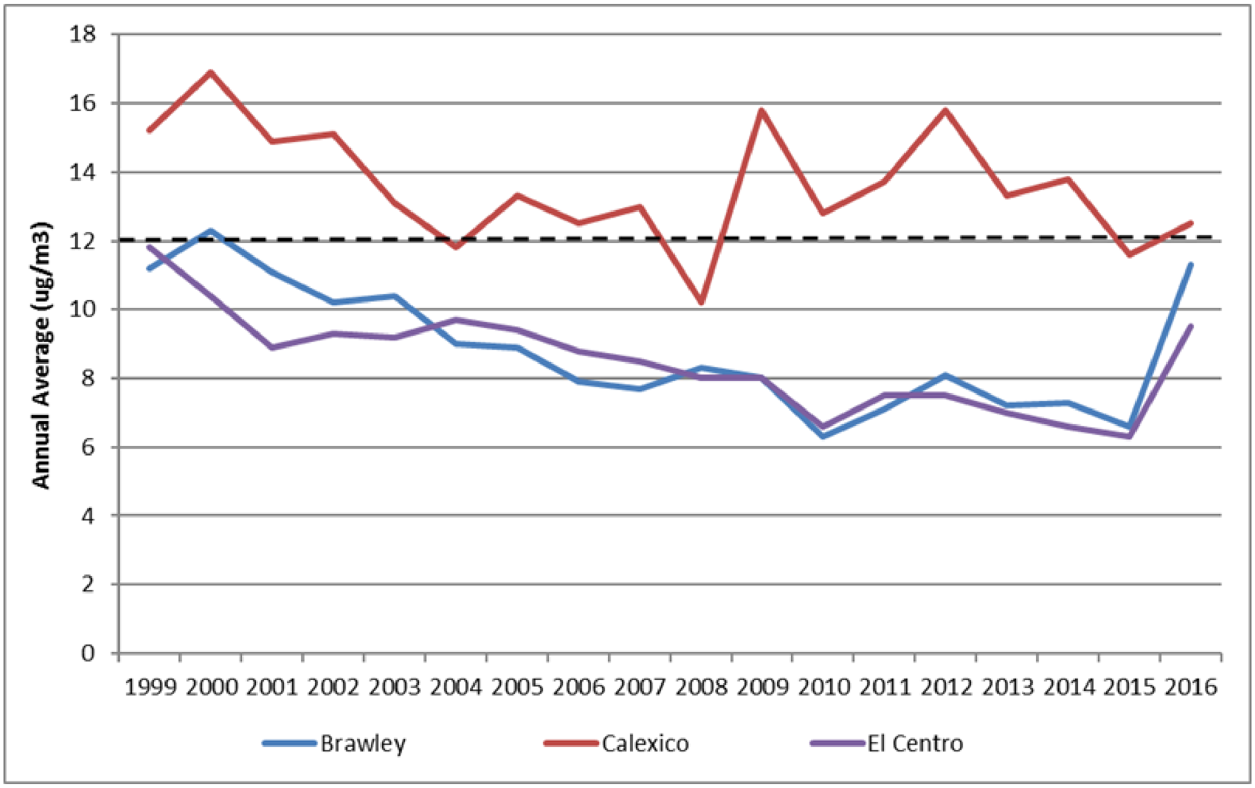
** $PM_{2.5}$ monitoring began in Imperial County in 1999; 2001 reflects the 1999-2001 design value year.*

*** The 2015 design value shown above is 12.9 µg/m^3 and does not include data from the SPM that was included in 2015 at Calexico. AQS includes data from the SPM in quarters 1 and 4 of 2015, which results in a design value of 13.1 µg/m^3.*

The trend in the annual average $PM_{2.5}$ at Calexico has improved significantly over the past few years. In 2014, the annual average at the Calexico monitor was 13.8 µg/m^3. In 2016, the annual average at Calexico decreased 10 percent to 12.5 µg/m^3. Although El Centro and Brawley annual averages did increase in 2016, they are still under the level of the annual standard. Analysis provided by CARB indicates that Calexico's high $PM_{2.5}$ levels occur mostly in the winter when winds are stagnant and $PM_{2.5}$ pollution increases. Figure 4-4 below shows the $PM_{2.5}$ annual average trend for the three stations located within the Imperial County $PM_{2.5}$ Nonattainment Area from 1999-2016.

[27] California Air Resources Board, Staff Report: Imperial County 2013 State Implementation Plan for the 2006 24-hour $PM_{2.5}$ Moderate Nonattainment Area; December 8, 2014 release date.

Figure 4-4. $PM_{2.5}$ Annual Average Trends for the Imperial County $PM_{2.5}$ Nonattainment Area (1999-2016)



**The observed increase between 2008 and 2009 is primarily the result of a reduced number of samples during that period coupled with high wintertime levels. Note that $PM_{2.5}$ samples collected at Calexico between November 5, 2008, and June 17, 2009 were invalidated due to failed sampler leak checks.*

***The annual average trend at Brawley and El Centro increased between 2015 and 2016 due to atypical $PM_{2.5}$ values recorded in the spring and summer. These values have been flagged as PM_{10} exceptional events in AQS.*

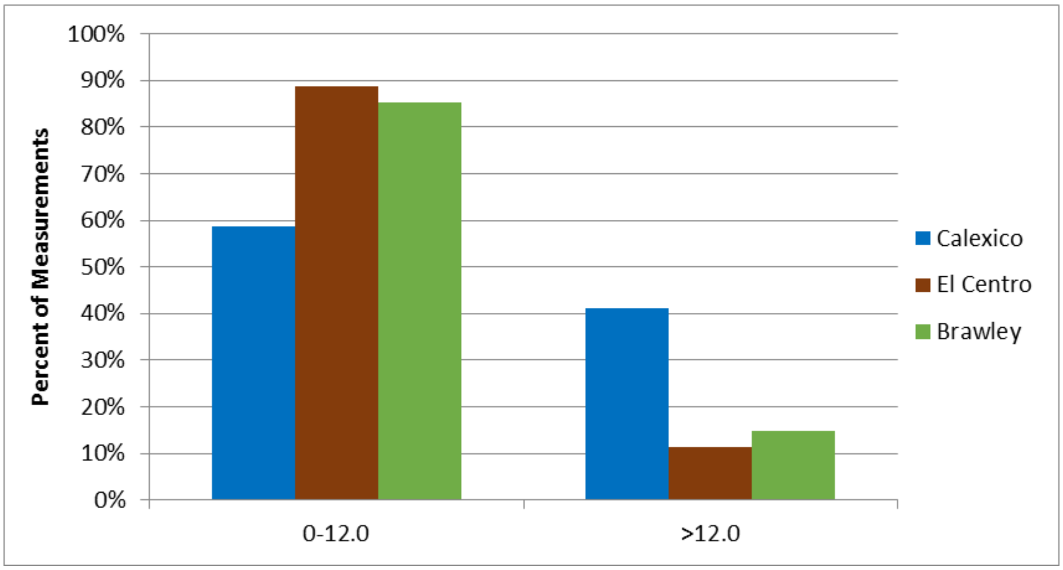
****2008, 2009, 2011, and 2012 annual average data were incomplete at Calexico.*

*****The annual average for 2015 shown above is 11.6 µg/m^3 and does not include data from the Special Purpose Monitor (SPM) at Calexico. AQS includes data from the SPM in quarters 1 and 4, which results in an annual average of 12.2 µg/m^3.*

To better assess $PM_{2.5}$ air quality in the Imperial County $PM_{2.5}$ Nonattainment Area over multiple years, daily $PM_{2.5}$ concentration values recorded at Calexico, El Centro, and Brawley between 2014 and 2016 were analyzed in relation to the 12.0 µg/m^3 $PM_{2.5}$ standard. The histogram in Figure 4-5 categorizes $PM_{2.5}$ data measured at the three Imperial County $PM_{2.5}$ Nonattainment Area sites between 2014 and 2016 into two bins with the upper end value of the first bin equal to the level of the annual $PM_{2.5}$ standard. The data show the percentage of measurements with concentrations within the annual $PM_{2.5}$ standard range and above the annual standard. Between 2014 and 2016, more than 40 percent of the $PM_{2.5}$ concentrations recorded at the Calexico monitoring site were over the annual standard of 12.0 µg/m^3, while El Centro and Brawley experienced concentrations over 12.0 µg/m^3 on approximately 10 percent of the days.

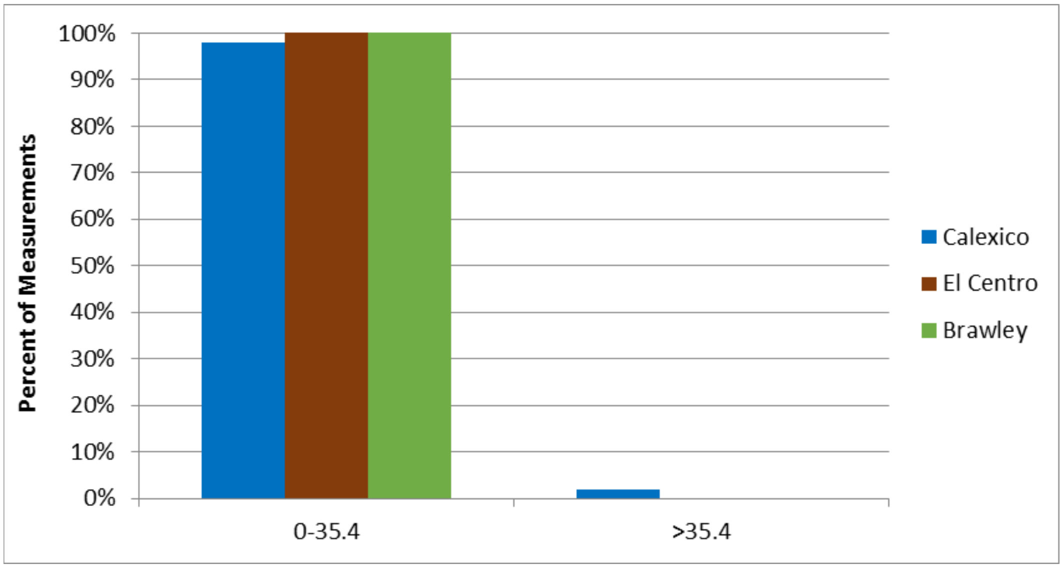
The data indicate that $PM_{2.5}$ concentrations measured at Calexico are above the annual standard at a higher frequency than other $PM_{2.5}$ sites in the Imperial County $PM_{2.5}$ Nonattainment Area. The El Centro and Brawley sites show a similar pattern with the majority of samples collected reflecting measured $PM_{2.5}$ values equal to or below the annual standard. While the cause for this difference is not evident from these data alone, the pattern suggests emission activities influencing Calexico are not regularly impacting monitoring sites farther to the north.

Figure 4-5. Percentage of $PM_{2.5}$ Values Relative to the Annual Standard: Calexico, El Centro, and Brawley (2014-2016)



A similar plot of $PM_{2.5}$ concentrations above the 35 µg/m³ 24-hour standard indicates that a greater number of values over the 24-hour standard occurred at the Calexico site than at either of the other sites (Figure 4-6). Because the annual standard is lower than the 24-hour standard, more values over 12.0 µg/m³ at each site are expected. The larger difference between values above the annual standard recorded at Calexico and sites farther from the border versus those differences associated with the 24-hour standard suggests that Calexico is experiencing a year-round influence of cross-border emissions resulting in exceedances of the annual standard.

Figure 4-6. Percentage of $PM_{2.5}$ Values Relative to the 24-Hour Standard: Calexico, El Centro, and Brawley (2014-2016)



To evaluate the temporal distribution of $PM_{2.5}$ concentrations above the standard, data plots were constructed using the average monthly concentration measured at Calexico, El Centro, and Brawley from 2014 through 2016 (Figure 4-7). In addition, time series plots were developed using the coincident $PM_{2.5}$ concentration data collected at Calexico, El Centro, and Brawley from 2014 through 2016 (Figure 4-8). For both data sets, only $PM_{2.5}$ FRM data were used for comparison purposes. Similar to the temporal pattern observed in the analysis conducted for the 24-hour Plan, the majority of days with higher $PM_{2.5}$ concentrations at Calexico occur during the winter months.[28]

[28] California Air Resources Board, Staff Report: Imperial County 2013 State Implementation Plan for the 2006 24-hour $PM_{2.5}$ Moderate Nonattainment Area; December 8, 2014 release date.

Figure 4-7. Average $PM_{2.5}$ FRM Concentration by Month from Monitoring Sites in Calexico, El Centro, and Brawley (2014 - 2016)

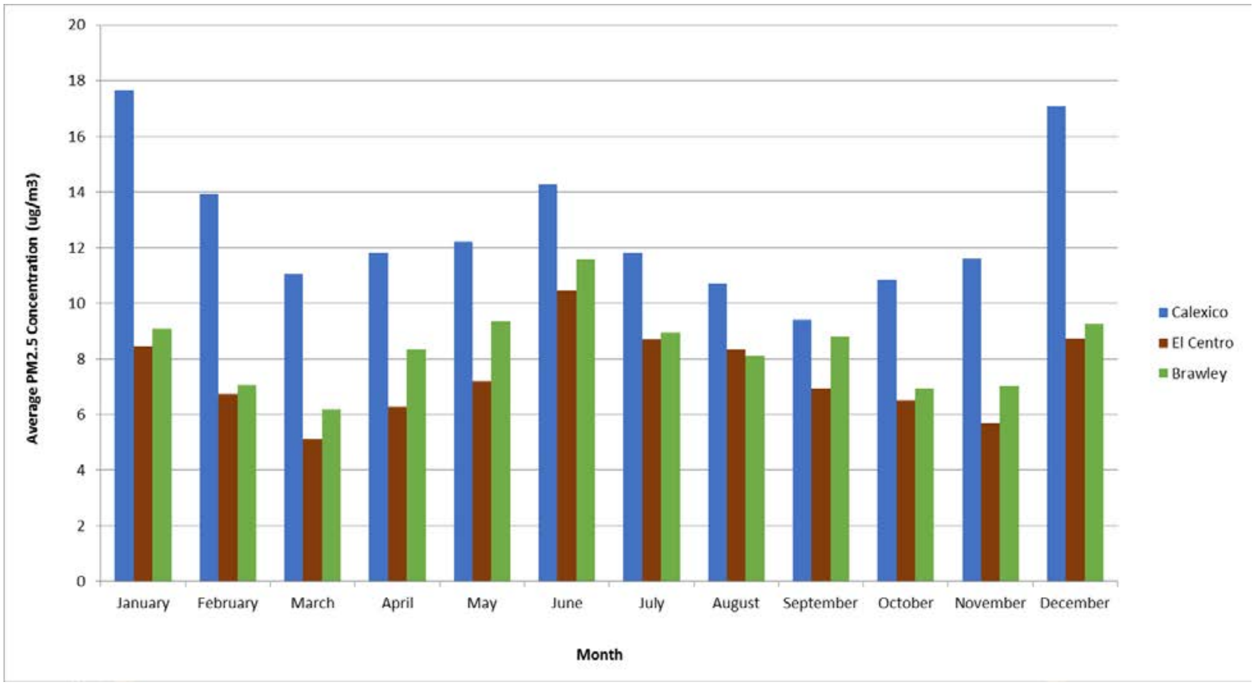
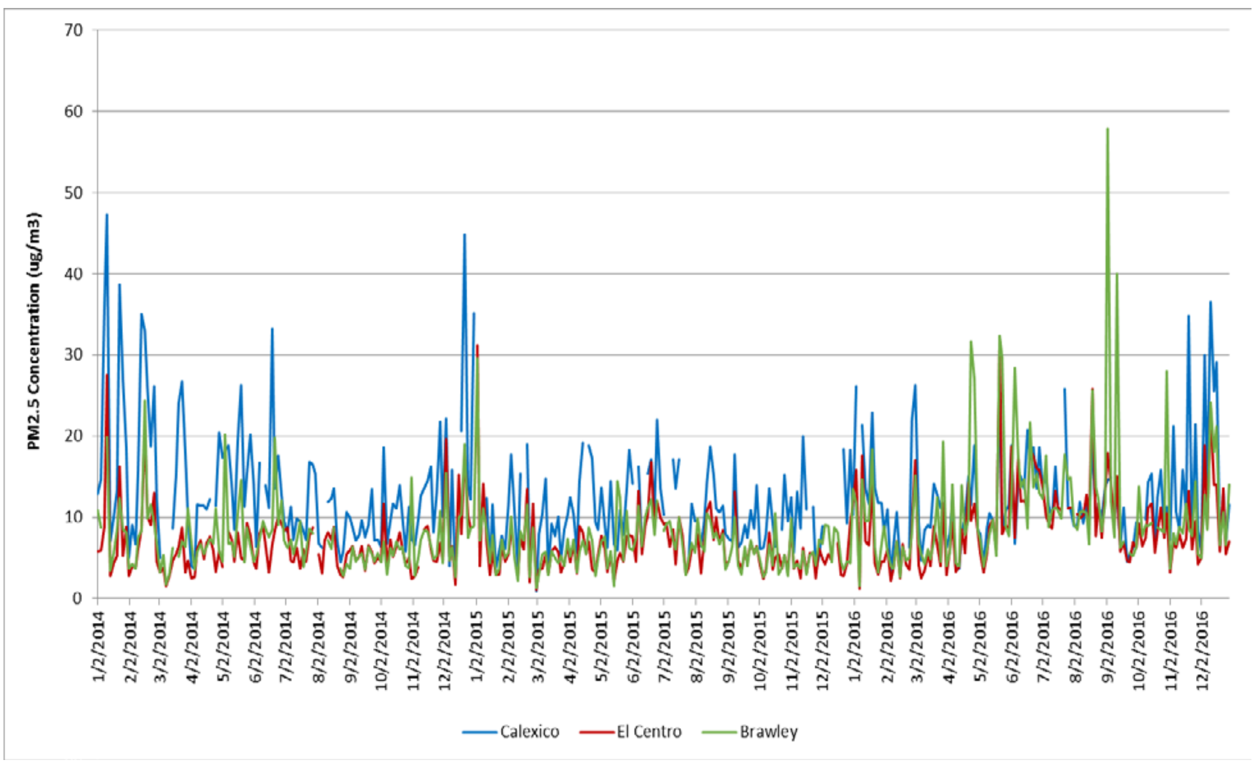


Figure 4-8. Coincident $PM_{2.5}$ FRM Values at Imperial County $PM_{2.5}$ Monitoring Sites (2014 - 2016)



Appendix A provides technical documentation that in 2021 the Imperial County $PM_{2.5}$ Nonattainment Area will not attain the annual $PM_{2.5}$ standard of 12.0 μg/m^3 when Mexico anthropogenic emissions are included and reasonable controls are in place in Imperial County. The CAA contains a specific provision in Section 179(B) for areas that are affected by the international cross-border transport of pollutants. Exceedances that occur due to international transport may cause violations of the standard; however, the CAA recognizes that an area might not be able to demonstrate attainment due to cross-border transport and thus contains provisions to ensure an area is taking appropriate actions and implementing local controls to decrease the impact of local emissions to protect public health.

Section 179(B) of the CAA for international border areas indicates that a SIP: "…shall be approved by the Administrator if—(1) [the implementation plan meets all applicable requirements other than the attainment demonstration requirement], and (2) the submitting state establishes…that the implementation plan…would be adequate to attain and maintain the…national ambient air quality standards (NAAQS) by the attainment date, but for emissions emanating from outside of the United States."[29] USEPA guidance issued in 1994 therefore indicated that those border areas that provide a technical justification of attainment but for emissions from foreign sources are relieved of certain planning requirements including the development of an attainment demonstration.[30] USEPA guidelines on demonstrating that an area is in attainment but for emissions emanating from outside the United States identify the types of information that may be used in evaluating the impact of emissions from outside the U.S. on nonattainment areas. States may use one or more of the approaches based on the specific circumstances and the data available.

Appendix A uses methods mentioned in the guidance to evaluate the potential impact of Mexicali emissions on the Calexico $PM_{2.5}$ monitor. Staff conducted various analyses using the monitoring data, meteorological conditions, and the emissions in the border region to evaluate the impacts of emissions emanating from Mexicali on attainment of the $PM_{2.5}$ annual standard. Staff also assessed Calexico speciation data and conducted a source apportionment analysis which tied speciation data to sources that are present in both the Imperial County $PM_{2.5}$ Nonattainment Area and Mexicali, Mexico. This apportionment method enabled a hypothetical calculation of the annual $PM_{2.5}$ design value if sources (specifically sources present in Mexicali) were excluded from consideration.

The main conclusions that were drawn from the 179(B) technical demonstration in Appendix A are summarized as follows:

1) Calexico is the only monitor in the Imperial County $PM_{2.5}$ Nonattainment Area that has a design value over the annual $PM_{2.5}$ standard. Design values at the northern nonattainment area sites are below the annual standard and almost half the level of Calexico.

2) $PM_{2.5}$ concentrations above the level of the annual standard occur throughout the year at Calexico, El Centro, and Brawley, although they are much less frequent at El Centro and Brawley.

[29] Clean Air Act Amendments of 1990: Public Law 101-549.
[30] See 59 FR 42000-42002 (August 16, 1994).

3) A gradient in $PM_{2.5}$ mass data is evident with the highest mass measurements recorded at the Calexico site and decreasing with increasing distance north of the border. Between 2012 and 2015, more than half of the $PM_{2.5}$ concentrations recorded at the Calexico monitoring site were over the annual standard of 12.0 μg/m^3, while less than 10 percent of the days at El Centro and Brawley exceeded 12.0 μg/m^3.

4) A comparison of the most recent comparable Imperial County $PM_{2.5}$ Nonattainment Area and Mexicali emission inventories for direct $PM_{2.5}$ and precursors estimates suggests a split in total $PM_{2.5}$ emissions with approximately 40 percent attributable to the Imperial County $PM_{2.5}$ Nonattainment Area and 60 percent attributable to Mexicali. Despite uncertainties associated with the Mexicali inventory, the magnitude of the difference between the Imperial County $PM_{2.5}$ Nonattainment Area and Mexicali emission inventories, combined with corresponding air quality differences, implies that the border region and the monitoring site in Calexico are heavily impacted by emissions transported across the border.

5) $PM_{2.5}$ levels measured at monitoring sites in the Imperial County $PM_{2.5}$ Nonattainment Area are affected by the distribution of wind direction. Aggregating hourly $PM_{2.5}$ concentrations with wind direction indicated that that while winds from the south occurred only 23 percent of the time, their contribution to the Calexico design value was 4.5 μg/m^3. Without the influence of southern winds and the corresponding Mexicali emissions, the Calexico monitoring site would be in attainment of the annual 12.0 μg/m^3 $PM_{2.5}$ standard.

6) Chemically speciated $PM_{2.5}$ data collected from the Calexico monitoring station show a seasonal pattern in $PM_{2.5}$ mass components with the highest concentrations of organic matter, elemental carbon, and ammonium nitrate occurring in winter. Geological dust is the second highest contributor to $PM_{2.5}$ at Calexico and remains fairly constant throughout the year, with slight increases in the fall and early winter months.

7) X-Ray Fluorescence analysis results indicate that elemental species concentrations increased with proximity to the border. The lowest values were observed at Brawley, about 22 miles north of the border, where the average concentration of non-geologic elements was 0.37 μg/m^3. Concentrations were twice as high at El Centro, about 9 miles north of the border, with an average of 0.63 μg/m^3. The non-geologic element concentrations reached a maximum at Calexico where the average sum of non-geologic elements was about 2.1 μg/m^3.

8) The gravimetric and speciation analyses show that $PM_{2.5}$ samples collected in Calexico differ substantially in chemical composition from samples collected at other locations around the state, implicating Mexicali as the source of a large portion of the emissions impacting the Calexico monitor.

9) An emissions density analysis was used to estimate the annual average $PM_{2.5}$ concentration that would exist at the Calexico station if the emission activities surrounding the station were the same as those to the north of the international border in the absence of Mexicali emission sources. The analysis showed that while the emission densities of Calexico, El Centro, and Brawley are essentially the same, $PM_{2.5}$ air quality at the Calexico station is substantially different than the two northern sites and that the difference is most likely due to impacts from Mexicali emission sources.

10) Source apportionment and source direction analyses indicated that refuse burning and certain industrial sources, contributing 15 percent of the total $PM_{2.5}$ mass in Calexico, originated from activities that are unknown in Imperial County. Source direction analyses showed the possibility that both industrial emissions and secondary sulfate precursor emissions originated from the same facilities.

11) Controls on industrial sources, refuse burning, and secondary sulfate could lower the 2014 design value at the Calexico monitoring site to 10.0 $\mu g/m^3$.

12) Modeling results show that in the absence of anthropogenic emissions in Mexico, the annual $PM_{2.5}$ design value for the Calexico monitor in 2021 will be below the annual standard at 11.7 $\mu g/m^3$.

Air quality modeling demonstrated what the annual average $PM_{2.5}$ design value would be at the Calexico $PM_{2.5}$ monitor in 2021 if emissions from Mexicali were reduced or eliminated completely. Considered together with air quality data and meteorological influences, the analyses in Appendix A demonstrate that in 2021, the Imperial County $PM_{2.5}$ Nonattainment Area would attain the annual $PM_{2.5}$ standard of 12.0 $\mu g/m^3$ in the absence of emissions from Mexico.

5 District Control Strategy

This chapter presents Imperial County's control strategy analysis for the 2012 $PM_{2.5}$ annual standard including a RACT/RACM assessment of current stationary, area, and mobile sources, other measures for consideration, and a SIP control strategy summary. As discussed in Section 3.17, CARB performed a comprehensive precursor demonstration to determine whether emissions of particular $PM_{2.5}$ precursors significantly contribute to $PM_{2.5}$ levels in the Imperial County $PM_{2.5}$ Nonattainment Area. Ultimately, the modeling component of this demonstration showed that none of the four $PM_{2.5}$ precursors significantly contribute to $PM_{2.5}$ levels in Imperial County. Therefore, the District is not required to address these precursors in its control measure analysis nor in its discussions regarding RFP, quantitative milestones, contingency measures, or transportation conformity, per the 2016 $PM_{2.5}$ Implementation Rule. This chapter and Chapter 6 predominantly focus on how the District addresses these various CAA requirements in the context of direct $PM_{2.5}$.

5.1 Control Measure Analysis Overview

Under Subpart 4, RACM and RACT are those measures that can and must be implemented within four years of an area's designation as nonattainment (pursuant to CAA Section 189(a)(1)(C)). USEPA has interpreted the RACM and RACT requirement in the CAA as requiring implementation of all reasonable controls as needed for expeditious attainment. USEPA recognizes that other, similarly reasonable emission reduction measures could be implemented after this four-year period, and as late as the end of the sixth calendar year following designation, to help an area attain as expeditiously as practicable. The 2016 $PM_{2.5}$ Implementation Rule terms those technologically and economically feasible control measures that could not be implemented within the four-year period after designation, but could be implemented starting any time after that four-year period through the end of the sixth calendar year after designation, as "additional reasonable measures" or ARM.

As discussed in the subsequent sections, with the exception of control measures addressing wood burning devices, the District's current rules along with state rules continue to satisfy RACT/RACM for the annual $PM_{2.5}$ standard. Therefore, Sections 5.3.2 and 5.5.1, present new control measures proposed by the District for the control of wood burning devices, one of which qualifies as RACM and the other ARM. In addition, the District has identified additional ARM (see Section 5.5) that would predominately affect NO_X and ammonia emissions. Even though Section 3.17 has demonstrated that these precursors do not contribute significantly to $PM_{2.5}$ levels in Imperial County, in the interest of completeness and given that the NO_X measures may affect ozone, they have been included in this SIP even though they would not appreciably affect $PM_{2.5}$ levels.

The 2016 $PM_{2.5}$ Implementation Rule notes the terms RACM and RACT are not defined within Subpart 4, nor do the provisions of Subpart 4 specify how states are to meet the RACM and RACT requirements. However, USEPA's longstanding guidance describes, in detail, considerations for determining what control measures constitute RACM and RACT for purposes of Subpart 4.

The 2016 $PM_{2.5}$ Implementation Rule requires states to include the following steps for identifying RACT/RACM. The District has followed this process and notes specific decisions made where flexibility was provided:

1. Identify all sources of emissions of direct $PM_{2.5}$, including major stationary sources as point sources, nonpoint sources (as defined by 40 CFR 51.50) including non-major point sources, and mobile sources.

2. Consider a variety of measures because RACT/RACM applies to stationary, mobile, and area sources. USEPA requires an air district to include a list of those control measures and technologies that are being implemented or will be implemented due to adopted regulations.

   USEPA notes that reducing air emissions may not justify adversely affecting other resources, for example, by increasing pollution in bodies of water, creating additional solid waste disposal problems, or creating excessive energy demands. Air districts are to provide reasoned judgment for such decisions in their SIPs.

3. Determine if the identified control measures or technologies are technologically feasible.

   USEPA reiterates its interpretation that technological feasibility includes consideration of factors such as a source's processes and operating procedures, materials, physical plant layout, and potential environmental impacts such as increased water pollution, waste disposal, and energy requirements. In regard to area and mobile sources, a state may consider relevant local factors in conducting its analysis, such as the condition and extent of needed infrastructure, population size, or workforce type and habits, which may prohibit certain potential control measures from being implementable.

4. Determine if any of the identified technologically feasible control measures and technologies are economically feasible. USEPA proposed the use of their longstanding interpretation of the term ''economic feasibility'', which involves considering the cost of reducing emissions and the difference between the cost of an emissions reduction measure at a particular source and the cost of emissions reduction measures that have been implemented at other similar sources in the same or other areas.

   Specifically, an evaluation of the economic feasibility of the control measure through consideration of the capital costs, operating and maintenance costs, and cost effectiveness (i.e., cost per ton of pollutant reduced by that measure or technology) associated with such measure or control must occur.

5. Determine which technologically and economically feasible measures can be implemented within four years from the date of designation and which can be implemented by the end of the sixth calendar year following designation.

   According to USEPA, the term ''implemented'' means that a control measure or technology has not only been submitted to USEPA for approval as part of a SIP, but has also been built, installed and/or otherwise physically manifested and is achieving the intended emissions reductions. However, USEPA recognizes that a state may be able to implement a given control measure only partially within four years after designation, and therefore requires a state to adopt as RACM or RACT that portion of a control measure or technology that can feasibly be implemented within four years of the effective date of designation.

6. Perform an analysis to determine the earliest practicable attainment date for the area and identify the control measures and control technologies that would be needed to achieve attainment by the demonstrated attainment date and to meet statutory control requirements.

   The statutory attainment date for Moderate nonattainment areas is as expeditiously as practicable, but no later than the end of the sixth calendar year after designation of the area as nonattainment (i.e., by the end of 2021). In the case of Moderate areas that can reach attainment by the statutory attainment date, and consistent with existing policies, states would be required to evaluate the combined effects of RACM that are not necessary to demonstrate attainment within the maximum statutory timeframe to determine whether implementation of the remaining measures could advance the attainment date by at least one year. USEPA has long applied this particular method to see if RACM that were not necessary to demonstrate attainment within the maximum statutory timeframe can collectively advance an area's applicable attainment date by at least one year, to satisfy provisions related to an area demonstrating attainment ''as expeditiously as practicable.'' In the case of Moderate areas that cannot practicably attain by the statutory attainment date, states would be required to implement all RACM and RACT, together with any ARM on sources in the nonattainment area.

5.2 Stationary Source RACM/RACT Analysis

There are currently no major stationary sources of $PM_{2.5}$ in the Imperial County $PM_{2.5}$ Nonattainment Area. However, at the suggestion of the USEPA, the District evaluated the emissions from the top $PM_{2.5}$ stationary sources in the region and assessed RACM/RACT for them. To do this, the District used CARB's emission inventory tool[31] to query the most recent emissions data (2015). As shown in Table 5-1, the top ten stationary sources of $PM_{2.5}$ in Imperial County had $PM_{2.5}$ emissions ranging from 118.01 tons per year (tpy) to 0.8 tpy. Six of these facilities, including the one with the highest emissions in 2015, are outside of the nonattainment area.

The remaining facilities include the Imperial Irrigation District (IID) El Centro facility, the Planters Hay Brawley facility, the Spreckels Sugar Brawley facility, and the Val-Rock Seeley facility. The District confirmed that the $PM_{2.5}$ emissions from the IID facility are primarily from natural gas combustion from turbines, which is considered Best Available Control Technology (BACT) for PM for turbines. For the Planters Hay facility, the District found that the $PM_{2.5}$ emissions are fugitive emissions from the hay compress operation. While this process is currently uncontrolled and a search of the USEPA RACT/BACT/LAER Clearinghouse and non-attainment area rules did not identify RACT for this process, the facility is regulated under ICAPCD Rule 207, the District's NSR rule (see Section 5.2.1). Were the facility to undergo a major modification, this rule would require BACT for emission units emitting 25 pounds per day or more of any nonattainment pollutants,

[31] CARB. Facility Search Engine. Available at: https://www.arb.ca.gov/app/emsinv/facinfo/facinfo.php. Accessed: January 2018.

including $PM_{2.5}$. For the Spreckels Sugar facility, the District found that the majority of the $PM_{2.5}$ emissions (3.6 tpy out of 3.9 tpy) are from the facility's natural gas boilers (which are BACT for PM). The remainder of the $PM_{2.5}$ emissions are from the facility's lime kiln (<0.3 tpy), which is controlled by a baghouse. Lastly, the District confirmed that the $PM_{2.5}$ emissions from the Val-Rock Seeley facility were from the asphalt operation, but that this facility closed in late 2016.

Table 5-1. Top $PM_{2.5}$ Stationary Sources in Imperial County

Facility Name	Facility City	2015 $PM_{2.5}$ Emissions (tpy) [a]	Inside $PM_{2.5}$ NA?	% of 2012 $PM_{2.5}$ NA Emission Inventory
Wester Mesquite Mines, Inc.	Brawley	83.68[b]	No	N/A
CalEnergy Operating Company Region 1	Calipatria	12.3	No	N/A
Imperial Irrigation District	**El Centro**	**11.3**	**Yes**	**0.25%**
U.S. Gypsum Company Quarry	Ocotillo Wells	6	No	N/A
Planters Hay, Inc.	**Brawley**	**5.7**	**Yes**	**0.13%**
A.W. Hoch	Calipatria	4.9	No	N/A
U.S. Gypsum Plaster City	Plaster City	4.1	No	N/A
Spreckels Sugar Co	**Brawley**	**3.9[c]**	**Yes**	**0.09%**
Val-Rock, Inc.	**Seeley**	**3.5**	**Yes**	**0.08%**
Ryerson Concrete	Niland	0.8	No	N/A

Notes:

[a] Values queried from CARB's Facility Search Engine. Available at: https://www.arb.ca.gov/app/emsinv/facinfo/facinfo.php. Accessed: January 2018.

[b] CARB indicated that the $PM_{2.5}$ value reported by the CARB Facility Search Engine is inaccurate. Revised value was provided by Elizabeth Melgoza (CARB) on 2/1/2018 via email and is included in this table.

[c] The District found that the $PM_{2.5}$ value reported by the CARB Facility Search Engine did not take into account the control provided by a dust collector installed on the facility's lime kiln. Revised value was provided by Reyes Romero (ICAPCD) on 2/7/2018 via email and is included in this table.

Abbreviations:

Inc. - incorporated

NA – nonattainment area

N/A – not applicable

$PM_{2.5}$ – particulate matter less than 2.5 microns in diameter

tpy – tons per year

U.S. – United States

For non-major stationary sources, RACT can be further assessed through a review of Control Technique Guidelines (CTG) and Alternative Control Technique (ACT) documents published by the USEPA.[32] CTG documents represent a presumption that RACT is met when existing rules meet the minimum emissions limitations given for a particular source category. ACT documents describe available control technologies and their respective cost effectiveness. There is currently only one CTG/ACT document that addresses particulate matter: Alternative Control Technique Document: Surface Coating Operations at Shipbuilding and Ship Repair Facilities. Because no such sources exist in Imperial County, the District made a negative declaration for this source category as part of its RACT assessment for the 2017 State Implementation Plan for the 2008 8-Hour Ozone Standard.[33] The District reaffirms this negative declaration for this Plan and concludes that the District's rules pertaining to direct $PM_{2.5}$ emissions satisfy RACT requirements for the annual $PM_{2.5}$ standard.

5.2.1 New Source Review (NSR)

There are other ICAPCD stationary source programs, such as NSR, that implement regulations on existing point sources. NSR is a permitting process required by the CAA to help ensure that any new or modified equipment or facilities (i.e., boilers, turbines, crude oil storage tanks, power plants, and factories) do not significantly degrade air quality or slow progress towards clean air. The District rule which dictates the CAA NSR requirements is Rule 207, *New and Modified Stationary Source Review*. There are two primary components of NSR: the application of BACT and the requirement for emission offsets. BACT plays a very important role in helping the District to meet the "no net increase" in emissions required by the CAA by acting as a limitation on pollutants emitted from or resulting from any new or modified stationary source. Emission reduction credits (ERCs) are credits which are issued to sources that have reduced their emissions in excess of what is required by law. ERCs must be permanent, real, enforceable, quantifiable, and surplus. ERCs are banked and made available for offsetting emission growth from new or modified emission units.

BACT is currently required for all new or modified emission units which have the potential to emit 25 pounds per day or more of any nonattainment pollutants, including $PM_{2.5}$. Sources are required to offset emission increases for each nonattainment pollutant (including $PM_{2.5}$) that results from a new major stationary source or major modification.

The NSR permit program in Imperial County currently enforces two versions of Rule 207. The first is a more recent version adopted as an amendment by the District Board of Directors on October 22, 2013 and the second is the SIP-approved rule version of Rule 207, Standards for Permit to Construct (except paragraph C.4), approved on November 10, 1980. On September 5, 2017, USEPA conditionally approved Rule 207, finding that the rule satisfies the statutory and

[32] CTG and ACT documents can be found at: https://www.epa.gov/ozone-pollution/control-techniques-guidelines-and-alternative-control-techniques-documents-reducing. Accessed: November 2017.

[33] Available at: https://www.arb.ca.gov/planning/sip/planarea/imperial/2017O3sip_final.pdf. Accessed: November 2017.

regulatory requirements for a general NSR permit program as set forth in CAA Section 110(a)(2)(c) and 40 CFR 51.160 – 51.164. However, USEPA determined that the rule does not regulate ammonia as a $PM_{2.5}$ precursor, which is a requirement under 40 CFR 51.165(a)(13). The District and the State have committed to revising Rule 207 to correct the deficiency and based on that assertion, USEPA has conditionally approved the rule.[34]

5.3 Area Source Analysis

The District evaluated the adequacy of its control measures on area (i.e., non-point) sources of direct $PM_{2.5}$ by reviewing the USEPA Office of Air Quality Planning and Standards' Menu of Control Measures (MCM),[35] a list that provides a broad set of emission reduction measures for different pollutants and source types. A summary of this evaluation is presented in Appendix C, which features a table that specifically lists each control measure in the MCM that pertains to area sources of PM. Each control measure was then evaluated against existing ICAPCD rules that address the same source(s). Several of the control measures were found to address sources already regulated by ICAPCD Regulation VIII rules, which have been recognized by the USEPA as meeting best available control measure (BACM) requirements for PM_{10}.[36] If a source type did not exist in Imperial County, it was noted in the table. From this analysis, it was determined that the District needed to implement control measures for residential wood combustion. Thus, new measures addressing this source are proposed as part of this SIP. See Sections 5.3.2 and 5.5.1 for additional discussion on these measures.

5.3.1 Agricultural Burning Rule Analysis

While the USEPA MCM includes a recommended control measure for open burning, that measure does not address agricultural burning, which historically has been a significant source of direct $PM_{2.5}$ in Imperial County. Imperial County currently controls agricultural burning through Rule 701. Rule 701 prohibits agricultural burning, except with a permit which is only valid for days on which burning is not prohibited by CARB, the fire control agency, or the air pollution control officer (APCO). Under this rule, the type of waste material that is allowed for burning is specified, along with appropriate drying times and the hours by which burning must cease. The rule was adopted prior to 1979, revised on August 13, 2002, and approved into the California SIP as RACM on January 31, 2003.[37]

Agricultural burning is further regulated under the Imperial County Smoke Management Plan (SMP), adopted in 2001 and revised in 2010. The SMP serves to control excessive smoke production that results from large-scale burning of crops. Since Imperial County includes large

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[34] USEPA. 2017. *Revisions to the California State Implementation Plan; Imperial County Air Pollution Control District; Stationary Sources Permits; Final Rule*. Federal Register. Vol. 82. No. 170. September 5, 2017. p. 41895.

[35] USEPA. 2012. Menu of Control Measures for NAAQS Implementation. April 12. Available at: https://www.epa.gov/criteria-air-pollutants/menu-control-measures-naaqs-implementation. Accessed: November 2017.

[36] USEPA. 2013. *Revisions to the California State Implementation Plan, Imperial County Air Pollution Control District; Final Rule.* Federal Register. Vol. 78. No. 77. April 22, 2013. p. 23677.

[37] USEPA. 2003. *Revisions to the California State Implementation Plan, Imperial County Air Pollution Control District and Monterey Bay Unified Air Pollution Control District; Direct Final Rule*. Federal Register. Vol. 68. No. 21. January 31, 2003. p. 4929.

swaths of cropland, many of which are burned regularly after harvest to prepare the fields for the next round of crops, the SMP is necessary to protect public health, ensure compliance with all ICAPCD rules, policies, and procedures, and ultimately maintain levels of ambient particulate matter below the applicable air quality standards. The SMP is enforced by ICAPCD and CARB staff who utilize meteorological and air monitoring resources to track smoke levels, air quality, and local conditions in order to determine the optimal hours for burning. From there, each day is officially declared as a “Permissive Burn Day”, “Marginal Burn Day”, or “No Burn Day”. Special consideration is given to burning activities near sensitive areas, such as residences and schools, and an inspector must be present at the time of ignition of these burns in order to make an assessment of the local conditions and grant approval for the burn. Finally, the SMP requires that ICAPCD staff maintain a daily burn log database and use it to submit an annual report of agricultural burning to CARB at the end of every calendar year.

Open burning in Imperial County has reduced over the last ten years not only in quantity but also in the number of types of crops burned. Specifically, Imperial County has successfully managed to curtail burning from a total of 40,221 acres of mixed crops in 2003 to 17,647 acres of field crops in 2016, primarily consisting of grass crops (e.g., Klein, Bermuda). This represents an approximate 56 percent reduction in agricultural burning since 2003. In support of the Imperial County 2013 SIP for the 2006 24-hour $PM_{2.5}$ standard, the District reviewed several managed burning and disposal rules promulgated by other agencies to determine if there were other measures that would enhance the current trend of reductions in agricultural burning in the County.[38] In particular, the following rules were reviewed:

- Monterey Bay Unified APCD - Rule 438: Open Outdoor Fires; revised February 19, 2014;
- South Coast AQMD - Rule 444: Open Burning; revised July 12, 2013;
- Placer County APCD - Rule 302: Agricultural Waste Burning Smoke Management; revised February 9, 2012;
- San Joaquin Valley APCD - Rule 4103: Open Burning; revised April 15, 2010.

In this analysis, the District found Rule 701 to be comparably stringent to the other rules. Furthermore, none of the other rules have been revised since the prior analysis. Therefore, no revisions to Rule 701 are being proposed as a part of this Plan. This rule comparison is organized into a table provided in Appendix E.

[38] See Attachment B at the following: https://www.arb.ca.gov/planning/sip/planarea/imperial/Final_PM2.5_SIP_%28Dec_2,_2014%29_Approved.pdf. Accessed: November 2017.

5.3.2 Control Measure: Wood Burning Fireplaces and Wood Burning Heaters – New Source Performance Standard Certification

The District is proposing a new rule that would achieve $PM_{2.5}$ emission reductions through the regulation of new wood burning fireplaces and wood burning heaters. The proposed rule would require new wood burning fireplaces (including fireplace inserts) and wood burning heaters in the Imperial County $PM_{2.5}$ Nonattainment Area to comply with New Source Performance Standard (NSPS) certification requirements in effect at the time of installation. This rule would be adopted in or before December 2018 and implementation would begin prior to April 15, 2019.

Control Measure Emission Reductions

District staff estimated the current $PM_{2.5}$ emissions related to residential wood combustion using the "Residential Wood Combustion" emission estimation methodology promulgated by CARB.[39] The District then calculated that with the implementation of this control measure through a rule, a 30 percent $PM_{2.5}$ emissions reduction would be achieved for residential wood stoves (Emission Inventory Category: 610-600-0230-0000), while a 20 percent $PM_{2.5}$ emissions reduction would be achieved for residential fireplaces (Emission Inventory Category: 610-602-0230-0000). Furthermore, it was assumed that these reductions would take place linearly over the course of ten years. Tables 5-2 and 5-3 indicate the current and estimated (i.e., with the new rule in place) residential wood combustion emissions for the Imperial County $PM_{2.5}$ Nonattainment Area.

[39] Available at: https://www.arb.ca.gov/ei/areasrc/fullpdf/full7-1_2011.pdf. Accessed: November 2017.

Table 5-2. Control Measure: Residential Wood Combustion $PM_{2.5}$ Emissions with NSPS Certification – $PM_{2.5}$ Nonattainment Area (tons per day) (Annual)

Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Wood Stoves (610-600-0230-0000)										
Current	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
With Control	0.004	0.004	0.004	0.004	0.003	0.003	0.003	0.003	0.003	0.003
Reduction	**0.000**	**0.000**	**0.000**	**0.000**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**
Fireplaces (610-602-0230-0000)										
Current	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028
With Control	0.027	0.027	0.026	0.026	0.025	0.025	0.024	0.024	0.023	0.022
Reduction	**0.001**	**0.001**	**0.002**	**0.002**	**0.003**	**0.003**	**0.004**	**0.004**	**0.005**	**0.006**
Combined Reduction	**0.001**	**0.001**	**0.002**	**0.003**	**0.003**	**0.004**	**0.005**	**0.005**	**0.006**	**0.007**
Notes: Totals may not add up due to rounding.										

Table 5-3. Control Measure: Residential Wood Combustion $PM_{2.5}$ Emissions with NSPS Certification – $PM_{2.5}$ Nonattainment Area (tons per year)

Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Wood Stoves (610-600-0230-0000)										
Current	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46
With Control	1.416	1.372	1.329	1.285	1.241	1.197	1.153	1.11	1.066	1.022
Reduction	**0.044**	**0.088**	**0.131**	**0.175**	**0.219**	**0.263**	**0.307**	**0.350**	**0.394**	**0.438**
Fireplaces (610-602-0230-0000)										
Current	10.22	10.22	10.22	10.22	10.22	10.22	10.22	10.22	10.22	10.22
With Control	10.016	9.811	9.607	9.402	9.198	8.994	8.789	8.585	8.380	8.176
Reduction	**0.204**	**0.409**	**0.613**	**0.818**	**1.022**	**1.226**	**1.431**	**1.635**	**1.840**	**2.044**
Combined Reduction	**0.248**	**0.496**	**0.745**	**0.993**	**1.241**	**1.489**	**1.737**	**1.986**	**2.234**	**2.482**
Notes: Totals may not add up due to rounding.										

5.4 State Mobile Source Program RACM Analysis

5.4.1 Overview

To fulfill CAA control measure requirements for Moderate $PM_{2.5}$ nonattainment areas, an assessment of control measures in the SIP must be performed. For Moderate nonattainment areas, the control measures must be shown to be RACM. Since CARB is responsible for measures to reduce emissions from mobile sources needed to attain the NAAQS, this section will discuss how California's mobile source measures meet RACM.

Given the severity of California's air quality challenges, CARB has implemented the most stringent mobile source emissions control program in the nation. CARB's comprehensive strategy to reduce emissions from mobile sources includes stringent emissions standards for new vehicles, in-use programs to reduce emissions from existing vehicle and equipment fleets, and cleaner fuels that minimize emissions. Taken together, California's mobile program meets RACM requirements in the context of $PM_{2.5}$ nonattainment.

5.4.2 RACM Requirements

Subpart 4, Section 189 (a)(1)(C) of the CAA requires SIPs to provide for the implementation of RACM within four years of nonattainment designation. CARB developed its State SIP Strategy through a multi-step measure development process, including extensive public consultation to develop and evaluate potential strategies for mobile source categories under CARB's regulatory authority that could contribute to expeditious attainment of the standard. First, CARB developed a series of technology assessments for heavy-duty mobile source applications and the fuels necessary to power them,[40] along with an ongoing review of advanced vehicle technologies for the light-duty sector in collaboration with USEPA and the National Highway Traffic Safety Administration. CARB staff then used a scenario planning tool to examine the magnitude of technology penetration necessary, as well as how quickly technologies need to be introduced to meet attainment of the standard.

CARB staff released a discussion draft Mobile Source Strategy[41] for public comment in October 2015. This strategy specifically outlined a coordinated suite of proposed actions to not only meet federal air quality standards, but also achieve greenhouse gas emission reduction targets, reduce petroleum consumption, and decrease health risks from transportation emissions over the next 15 years. CARB staff held a public workshop on October 16, 2015 in Sacramento and on October 22, 2015, CARB held a public Board meeting to update the Board and solicit public comment on the Mobile Source Strategy in Diamond Bar, California.

Staff continued to work with stakeholders to refine the measure concepts for incorporation into related planning efforts including the 75 ppb 8-hour ozone SIPs. In May 2016, CARB released an updated Mobile Source Strategy. On May 17, 2016, CARB released the proposed State SIP

[40] Technology and fuel assessment information available at: http://www.arb.ca.gov/msprog/tech/tech.htm. Accessed: November 2017.

[41] CARB 2016 Mobile Source Strategy available at: http://www.arb.ca.gov/planning/sip/2016sip/2016mobsrc.htm. Accessed: November 2017.

strategy for a 45-day public comment period and held a workshop on September 1, 2016. The measure concepts have implementation schedules beyond four years. The Mobile Source Strategy was adopted by CARB in March 2017. During the public process, no measures were identified that could be implemented within the four year timeframe. Therefore, the current mobile source program is considered at a minimum RACM for Moderate $PM_{2.5}$ nonattainment areas.

5.4.3 Waiver Approvals

While the Act preempts most states from adopting emission standards and other emission-related requirements for new motor vehicles and engines, it allows California to seek a waiver or authorization from the federal preemption to enact emission standards and other emission-related requirements for new motor vehicles and engines and new and in-use off-road vehicles and engines that are at least as protective as applicable federal standards, except for locomotives and engines used in farm and construction equipment which are less than 175 horsepower (hp).

Over the years, California has received waivers and authorizations for over 100 regulations. The most recent California standards and regulations that have received waivers and authorizations are Advanced Clean Cars (including zero-emission vehicles [ZEV] and low-emission vehicles [LEV] III) for light-duty vehicles and On-Board Diagnostics, Heavy-Duty Idling, Malfunction and Diagnostics System, In-Use Off-Road Diesel Fleets, Large Spark Ignition Fleet, and Mobile Cargo Handling Equipment for heavy-duty engines. Other authorizations include Off-Highway Recreational Vehicles and the Portable Equipment Registration Program.

Finally, CARB obtained an authorization from USEPA to enforce adopted emission standards for off-road engines used in yard trucks and two-engine sweepers. CARB adopted the off-road emission standards as part of its “Regulation to Reduce Emissions of Diesel Particulate Matter, Oxides of Nitrogen and Other Criteria Pollutants from In-Use Heavy-Duty Diesel-Fueled Vehicles,” (Truck and Bus Regulation). The bulk of the regulation applies to in-use heavy-duty diesel on-road motor vehicles with a gross vehicle weight rating in excess of 14,000 pounds, which are not subject to preemption under section 209(a) of the CAA and do not require a waiver under section 209(b).

5.4.4 Light and Medium Duty Vehicles

Light- and medium-duty vehicles are currently regulated under California’s Advanced Clean Cars program including the LEV III and ZEV programs. Other California programs, such as the 2012 Governor Brown Executive Order to put 1.5 million zero-emission vehicles on the road by 2025 and California’s Reformulated Gasoline program (CaRFG) will produce substantial and cost-effective emission reductions from gasoline-powered vehicles.

Taken together, California’s emission standards and fuel specifications for on-road light- and medium-duty vehicles represent all measures that are technologically and economically feasible in the context of a RACM assessment.

5.4.5 Heavy Duty Vehicles

California’s heavy-duty vehicle emissions control program includes requirements for increasingly tighter new engine standards and addresses vehicle idling, certification procedures, on-board diagnostics, emissions control device verification, and in-use vehicles. This program is designed to achieve an on-road heavy-duty diesel fleet with 2010 engines emitting 98 percent less NO_X and $PM_{2.5}$ than trucks sold in 1986.

Most recently, in the ongoing efforts to go beyond federal standards and achieve further reductions, CARB adopted the Optional Reduced Emissions Standards for Heavy-Duty Engines regulation in 2014 that establishes the new generation of optional NO_X emission standards for heavy-duty engines.

The recent in-use control measures include On-Road Heavy-Duty Diesel Vehicle (In-Use) Regulation, Drayage (Port or Rail Yard) Regulation, Public Agency and Utilities Regulation, Solid Waste Collection Vehicle Regulation, Heavy-Duty (Tractor-Trailer) Greenhouse Gas Regulation, Airborne Toxic Control Measure to Limit Diesel-Fueled Commercial Motor Vehicle Idling, Heavy-Duty Diesel Vehicle Inspection Program, Periodic Smoke Inspection Program, Fleet Rule for Transit Agencies, Lower-Emission School Bus Program, and Heavy-Duty Truck Idling Requirements.

Taken together, California's emission standards and fuel specifications for heavy-duty vehicles represent all measures that are technologically and economically feasible in the context of a RACM assessment.

5.4.6 Off-Road Vehicles and Engines

California regulations for off-road equipment include not only increasingly stringent standards for new off-road diesel engines, but also in-use requirements and idling restrictions. The Off-Road Regulation is an extensive program designed to accelerate the penetration of the cleanest equipment into California's fleets and impose idling limits on off-road diesel vehicles. The program goes beyond emission standards for new engines through comprehensive in-use requirements for legacy fleets.

Taken together, California's comprehensive suite of emission standards and fuel specifications for off-road vehicles and engines represent all measures that are technologically and economically feasible in the context of a RACM assessment.

5.4.7 Other Sources and Fuels

The emission limits established for other mobile source categories, coupled with USEPA waivers and authorization of preemption, establish that California's programs for motorcycles, recreational boats, off-road recreational vehicles, cargo handling equipment, and commercial harbor craft sources meet the requirements for RACM.

Cleaner burning fuels also play an important role in reducing emissions from motor vehicles and engines as CARB has adopted a number of more stringent standards for fuels sold in California, including the Reformulated Gasoline program, low-sulfur diesel requirements, and the Low Carbon Fuel Standard. These fuel standards, in combination with engine technology requirements, ensure that California's transportation system achieves the most effective emission reductions possible.

Taken together, California's emission standards and fuel specifications for other mobile sources and fuels represent all measures that are technologically and economically feasible in the context of a RACM assessment.

5.4.8 Mobile Source RACM Summary

California's long history of comprehensive and innovative emissions control has resulted in the most stringent mobile source control program in the nation. USEPA has previously acknowledged the strength of the program in their approval of CARB's regulations and through the waiver process. Since then, CARB has continued to substantially enhance and accelerate reductions from the state's mobile source control programs through the implementation of more stringent engine emissions standards, in-use requirements, and other policies and initiatives as described in the preceding sections.

The CARB process for developing the proposed state measures included an extensive public process and was consistent with USEPA RACM guidance. Through this process, CARB found that there are no additional RACM that would advance attainment of the 12 $\mu g/m^3$ $PM_{2.5}$ standard in the Imperial County Nonattainment Area from emissions reductions associated with unused regulatory control measures. As a result, California's mobile source control programs fully meet the requirements for RACM.

5.5 Additional Reasonable Measures (ARM)

As mentioned in previous sections of this Chapter, controls that are technologically and economically feasible that cannot be implemented within the four-year period after designation, but could be implemented starting any time after that four-year period through the end of the sixth calendar year after designation, are termed "additional reasonable measures", or ARM.

Through the area source analysis described in in Section 5.3, the District identified control measures related to residential wood combustion that would qualify as RACM and ARM. Apart from that analysis, the District identified ARM related to sources of NO_X and NH_3. While the modeling component of the comprehensive precursor demonstration (discussed in Section 3.17) has indicated that $PM_{2.5}$ precursors do not have a significant impact on $PM_{2.5}$ levels causing nonattainment, the District is committed to the continued improvement of air quality in the region and thus is presenting additional control measures related to these sources as part of this SIP.

The following is a list of the $PM_{2.5}$, NO_X, and NH_3 sources in Imperial County that have been identified for ARM:

- Wood burning fireplaces and wood burning heaters (curtailment);
- Boilers, steam generators, and process heaters;
- Biosolids, animal manure, and poultry litter composting operations; and
- Residential water heaters.

The following sections discuss the rules that would implement the ARM related to these sources.

5.5.1 Control Measure: Wood Burning Fireplaces and Wood Burning Heaters–Curtailment

The District is proposing a new rule to implement a control measure that would prohibit/curtail the combustion of wood or solid-fuel products in any wood-burning device in the city of Calexico during a curtailment period (areas outside of Calexico have historically not exceeded either the 24-hour average or annual average $PM_{2.5}$ standards). The curtailment period would be defined as any period so declared to the public by the APCO when $PM_{2.5}$ levels are forecast to exceed 35 µg/m^3 at the Calexico monitor. Similar rules have been adopted by other Air Quality Management Districts (AQMDs), including the Bay Area AQMD (Regulation 6, Rule 3), Sacramento Metropolitan AQMD (Rule 421), and South Coast AQMD (Rule 445). This rule would be adopted in or before December 2018 and implementation would begin in 2020. Implementation would be delayed one year to allow the District to develop and identify a source of funding for an incentive program for Calexico residents to purchase devices that may operate during mandated curtailment, such as gaseous-fueled devices. Delayed implementation would also provide the District with a winter period in which they could educate the populace regarding the concept of curtailment, possibly with voluntary curtailment campaigns, and thus ensure successful implementation of the control measure in 2020 when mandated curtailment provisions are in place.

Control Measure Emission Reductions

Potential reductions from implementation of this control measure through this rule were evaluated by analyzing the three most recent years of 24-hour $PM_{2.5}$ data from the primary Calexico monitor (2014-2016). From the data it was determined that there would be on average six curtailment days per year in the winter months (defined as November-February) with a curtailment threshold of 35 µg/m^3. Emission reductions were estimated by adjusting the average daily winter $PM_{2.5}$ emissions for Imperial County for the estimated reductions due to occur from the NSPS Certification Rule (described in Section 5.3.2). The adjusted value was then scaled down by population fraction to reflect the proportion of emissions attributable to Calexico. It was then assumed that there would be a 75 percent compliance rate with the curtailment order. The resulting daily emissions estimate was multiplied by six to determine the total reductions for the year. Estimated reductions by year are shown in Table 5-4. More detailed calculations are presented in Appendix D.

Table 5-4. Control Measure: Residential Wood Combustion $PM_{2.5}$ Emission Reductions with Curtailment			
Year	**2020**	**2021**	**2022**
Reduction (tpd)	0.00019	0.00018	0.00018
Reduction (tpy)	0.068	0.067	0.066
Abbreviations: tpd – tons per day tpy – tons per year			

5.5.2 Control Measure: Boilers, Steam Generators, and Process Heaters

To implement this control measure, the District is proposing a new rule that will limit NO_X emissions from boilers, steam generators, and process heaters rated 0.075 million British thermal units per hour (MMBtu/hr) to less than 5.0 MMBtu/hr. The new rule would affect emissions under the Manufacturing and Industrial (Emission Inventory Category: 050-995-0110-0000) and Service and Commercial (Emission Inventory Category: 060-995-0110-0000) subcategories under the Fuel Combustion Category of the Imperial County $PM_{2.5}$ Nonattainment Area emissions inventory. Similar rules have been adopted by SCAQMD (Rules 1146.1 and 1146.2), SJVAPCD (Rules 4307 and 4308), and Ventura County APCD (Rules 74.11.1 and 74.15.1).

The new proposed Boiler, Steam Generators, and Process Heaters Rule will limit NO_X emissions to less than or equal to 20 parts per million (ppm) of NO_X emissions (at 3 percent oxygen [O_2] dry). The limit will apply to new and replacement units rated 0.075 MMBtu/hr to less than 5.0 MMBtu/hr. It is estimated the rule would be adopted in or before December 2019 and implemented in 2020.

Control Measure Emissions Reductions

Based on the District's knowledge of the current population of boilers, steam generators, and process heaters in the 0.075 to 5.0 MMBtu/hr range, District staff assumes that 15 percent of NO_X emissions from the Manufacturing and Industrial subcategory and 84 percent of NO_X emissions under the Service and Commercial subcategory will be affected by the new rule. The District also assumes all of the equipment will be replaced within 20 years, which is assumed to be the useful life of the equipment. It is also assumed that the current equipment has a NO_X emission factor of 55 ppm NO_X emissions (at 3 percent O_2 dry) and would eventually have to comply with a NO_X emission limit of 20 ppm per joule of heat input which calculates to a 50 percent reduction in NO_X emissions. It is assumed that the emissions reductions will take place linearly over the course of the 20 years. This will result in an estimated total NO_X emission reduction of 7.5 percent for Manufacturing and Industrial natural gas combustion and a 42 percent reduction for Service and Commercial natural gas combustion. Tables 5-5 and 5-6 present the current and estimated (i.e., with the new rule in place) emissions for the Imperial County $PM_{2.5}$ Nonattainment Area.

Table 5-5. Control Measure: Industrial and Commercial Natural Gas Combustion with Boilers, Steam Generators and Water Heaters NO_X Emissions – $PM_{2.5}$ Nonattainment Area (tons per day) (Annual)

Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Manufacturing and Industrial (050-995-0110-0000)																	
Current	0.347	0.382	0.377	0.373	0.368	0.365	0.361	0.358	0.354	0.351	0.349	0.347	0.346	0.345	0.344	0.342	0.390
With Control	0.347	0.381	0.374	0.369	0.362	0.358	0.353	0.348	0.343	0.339	0.336	0.333	0.330	0.328	0.326	0.323	0.367
Reduction	**0.000**	**0.001**	**0.003**	**0.004**	**0.005**	**0.007**	**0.008**	**0.010**	**0.011**	**0.012**	**0.013**	**0.015**	**0.016**	**0.017**	**0.018**	**0.019**	**0.024**
Service and Commercial (060-995-0110-0000)																	
Current	0.539	0.597	0.592	0.587	0.582	0.578	0.575	0.572	0.570	0.569	0.570	0.572	0.572	0.574	0.575	0.576	0.661
With Control	0.539	0.584	0.567	0.550	0.533	0.517	0.502	0.488	0.474	0.461	0.450	0.440	0.428	0.417	0.406	0.395	0.439
Reduction	**0.000**	**0.013**	**0.025**	**0.037**	**0.049**	**0.061**	**0.073**	**0.084**	**0.096**	**0.108**	**0.120**	**0.132**	**0.144**	**0.157**	**0.169**	**0.181**	**0.222**
Combined Reduction	**0.000**	**0.014**	**0.028**	**0.041**	**0.055**	**0.068**	**0.081**	**0.093**	**0.106**	**0.119**	**0.133**	**0.147**	**0.160**	**0.173**	**0.187**	**0.201**	**0.245**

Notes:
Totals may not add up due to rounding.

Table 5-6. Control Measure: Industrial and Commercial Natural Gas Combustion with Boilers, Steam Generators and Water Heaters NO_X Emissions – $PM_{2.5}$ Nonattainment Area (tons per year)

Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Manufacturing and Industrial (050-995-0110-0000)																	
Current	126.7	139.4	137.6	136.1	134.3	133.2	131.8	130.7	129.2	128.1	127.4	126.7	126.3	125.9	125.6	124.8	142.4
With Control	126.7	138.9	136.6	134.6	132.3	130.7	128.8	127.2	125.3	123.8	122.6	121.4	120.6	119.8	119	117.8	133.8
Reduction	**0**	**0.5**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**3.9**	**4.3**	**4.8**	**5.3**	**5.7**	**6.1**	**6.6**	**7**	**8.6**
Service and Commercial (060-995-0110-0000)																	
Current	196.7	217.9	216.1	214.3	212.4	211	209.9	208.8	208.1	207.7	208.1	208.8	208.8	209.5	209.9	210.2	241.3
With Control	196.7	213.3	207	200.8	194.6	188.8	183.4	178.1	173.1	168.4	164.4	160.6	156.2	152.3	148.2	144	160.2
Reduction	**0**	**4.6**	**9.1**	**13.5**	**17.8**	**22.2**	**26.5**	**30.7**	**35**	**39.3**	**43.7**	**48.2**	**52.6**	**57.2**	**61.7**	**66.2**	**81.1**
Combined Reduction	**0.0**	**5.1**	**10.1**	**15.0**	**19.9**	**24.7**	**29.4**	**34.1**	**38.8**	**43.6**	**48.5**	**53.5**	**58.3**	**63.3**	**68.3**	**73.2**	**89.6**

Notes:
Totals may not add up due to rounding.

5.5.3 Control Measure: Biosolids, Animal Manure, and Poultry Litter Composting Operations

To implement this measure, the District is proposing a new rule that would regulate biosolids, animal manure, and poultry litter composting operations. Specifically, facilities would be required to follow certain management procedures to control ammonia emissions. The new rule would affect emissions under the Composting Solid Waste category (Emission Inventory Category: 199-170-0240-0000) of the emissions inventory. The new rule would be similar to SJVAPCD's Biosolids, Animal Manure, and Poultry Litter Operations Rule (Rule 4565). Imperial County composting operations largely involve the composting of animal manure, which comes from the County's large confined feedlot operations. It is estimated the rule would be adopted in or before December 2019 and implementation would begin in 2020.

Control Measure Emissions Reductions:

The District conducted the ammonia emissions reduction analysis by following CARB's Emissions Inventory Methodology for Composting Facilities.[42] Reductions were calculated assuming that facilities would implement water management practices to control ammonia emissions. Based on Table III-3 Control Techniques for Composting Operations, implementing water management practices corresponds to a 19 percent reduction in ammonia emissions. Note, CARB's Emissions Inventory Methodology is geared towards facilities with a high volume of greenwaste in their compost mixtures. More research may need to be done to determine the final reductions in ammonia emissions expected to occur due to this rule. Tables 5-7 and 5-8 indicate current and proposed emissions under the Solid Waste Composting emissions category for the Imperial County $PM_{2.5}$ Nonattainment Area. It is assumed the reductions will begin to take place in the year 2020.

Table 5-7. Control Measure: Solid Waste Composting NH_3 Emissions – $PM_{2.5}$ Nonattainment Area (tons per day) (Annual)

Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Current	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14
With Control	1.14	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Reduction	**0**	**0.22**	**0.22**	**0.22**	**0.22**	**0.22**	**0.22**	**0.22**	**0.22**	**0.22**	**0.22**

[42] CARB. 2015. ARB Emissions Inventory Methodology for Composting Facilities. March 2. Available at: https://www.arb.ca.gov/ei/areasrc/Composting%20Emissions%20Inventory%20Methodology%20Final%20Combined.pdf. Accessed: November 2017.

Table 5-8. Control Measure: Solid Waste Composting NH_3 Emissions – $PM_{2.5}$ Nonattainment Area (tons per year)											
Year	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
Current	416.8	416.8	416.8	416.8	416.8	416.8	416.8	416.8	416.8	416.8	416.8
With Control	416.8	337.6	337.6	337.6	337.6	337.6	337.6	337.6	337.6	337.6	337.6
Reduction	**0**	**79.2**	**79.2**	**79.2**	**79.2**	**79.2**	**79.2**	**79.2**	**79.2**	**79.2**	**79.2**

5.5.4 Control Measure: Residential Water Heaters

To implement this measure, the District is proposing a new rule that would limit NO_X emission rates from new residential water heaters rated less than 75,000 Btu/hr. Specifically, the proposed rule would limit NO_X emissions to 15 ppm (at 3 percent O_2 dry). The new rule would affect emissions classified under the category known as Residential Fuel Combustion – Natural Gas – Water Heater (Emission Inventory Category: 610-608-0110-0000). This new rule would be similar to SJVAPCD's Rule 4902, SCAQMD's Rule 1121, and Ventura County APCD's Rule 74.11. It is estimated the rule would be adopted in or before 2019 and implemented in 2020.

Control Measure Emission Reductions

The District conducted a survey of local home improvement stores and determined that the residential water heaters currently being sold within the county are certified to meet a limit of 55 ppm of NO_X emissions (at 3 percent O_2 dry). Adopting the new rule will lead to new residential water heaters with the updated NO_X emission limits replacing existing heaters in upcoming years. A reduction from a limit of 55 ppm NO_X to 15 ppm corresponds to an approximate 75 percent reduction in emissions. Assuming this reduction takes place over the course of 10 years as old water heaters are replaced, an incremental rate of 7.5 percent reduction of the total annual emissions will occur each year. Tables 5-9 and 5-10 indicate the current and estimated NO_X emissions through 2035 for the Imperial County $PM_{2.5}$ Nonattainment Area.

Table 5-9. Control Measure: Residential Water Heater NO_X Emissions – $PM_{2.5}$ Nonattainment Area (tons per day) (Annual)

Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Current	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022
With Control	0.022	0.021	0.019	0.017	0.015	0.014	0.012	0.010	0.009	0.007	0.006	0.006	0.006	0.006	0.006	0.006	0.006
Reduction	**0**	**0.002**	**0.003**	**0.005**	**0.007**	**0.008**	**0.010**	**0.012**	**0.013**	**0.015**	**0.016**	**0.016**	**0.016**	**0.016**	**0.016**	**0.016**	**0.016**

Table 5-10. Control Measure: Residential Water Heater NO_X Emissions – $PM_{2.5}$ Nonattainment Area (tons per year)

Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Current	8.03	8.03	8.03	8.03	8.03	8.03	8.03	8.03	8.03	8.03	8.03	8.03	8.03	8.03	8.03	8.03	8.03
With Control	8.03	7.765	6.826	6.223	5.621	5.019	4.417	3.814	3.212	2.61	2.008	2.008	2.008	2.008	2.008	2.008	2.008
Reduction	**0**	**0.63**	**1.204**	**1.807**	**2.409**	**3.011**	**3.613**	**4.216**	**4.818**	**5.42**	**6.022**	**6.022**	**6.022**	**6.022**	**6.022**	**6.022**	**6.022**

5.6 Incentive Programs

The majority of the new measures in the California state mobile source strategy encompass in-use measures which have traditionally resulted in flexible regulation, allowing cost-effective methods to be used by those having to meet emissions requirements. Therefore, to accomplish early retirement of older, more polluting engines, the use of funding programs, such as the Enhanced Fleet Modernization Program, the Clean Vehicle Rebate Project, the Air Quality Improvement Program, and the Carl Moyer Program, plays an important role in achieving additional emission reductions for Imperial County.

For example, the Carl Moyer Program encourages the early introduction of clean air technologies into the on-road and off-road vehicle fleets by providing grants that local air districts can administer to help with the purchase of new vehicles or new engines (repowers) or for the installation of retrofit units on older engines. A variety of vehicle classes and types are funded under the Carl Moyer Program. In particular, this funding provides the technologies that reduce NO_X and PM emissions caused by the combustion of diesel powered engines. In Imperial County, projects funded under the Carl Moyer Program have historically included retrofits and replacement of portable engines such as dirty burning irrigation pumps, agricultural drain cleaners, and tractors. In total, 195 projects have been funded since the funding cycle year 3.

This SIP does not include any emission reductions associated with incentive programs in the emission inventories or the attainment demonstration.

5.7 Control Strategy Summary

The control strategy consists of adopted measures summarized in sections 5.2 through 5.6, the new RACM control measure for primary $PM_{2.5}$ emissions, as well as the new ARM control measures for $PM_{2.5}$, NO_X, and ammonia emissions. The new control measures being proposed with this Plan are summarized in Table 5-11.

Table 5-11. ICAPCD Proposed Control Measures for the 2012 Annual $PM_{2.5}$ Standard

Measure Type	Measure Title	Adoption Year / Implementation Year	Pollutant	Implementing Agency	Reductions (Annual tpd) (2019 / 2022)[a]
RACM	Wood Burning Fireplaces and Wood Burning Heaters – NSPS Certification	2018 / 2019[b]	$PM_{2.5}$	ICAPCD	0.00068/0.0027
ARM	Wood Burning Fireplaces and Wood Burning Heaters– Curtailment	2018 / 2020	$PM_{2.5}$	ICAPCD	0/0.00018
ARM	Boilers, Steam Generators, and Process Heaters	2019 / 2020	NO_X	ICAPCD	0/0.041
ARM	Biosolids, Animal Manure, and Poultry Litter Composting Operations	2019 / 2020	NH_3	ICAPCD	0/0.22
ARM	Residential Water Heaters	2019 / 2020	NO_X	ICAPCD	0/0.005

Notes:

[a] The reductions in this table focus on the years 2019 and 2022, as those are milestone years.

[b] The District intends to implement this control measure prior to April 15, 2019.

Abbreviations:

ARM – additional reasonable measures

ICAPCD – Imperial County Air Pollution Control District

NH_3 - ammonia

NO_X – oxides of nitrogen

NSPS – New Source Performance Standard

$PM_{2.5}$ – particulate matter less than 2.5 microns in diameter

RACM – reasonably available control measures

tpd – tons per day

USEPA – United States Environmental Protection Agency

6 Other Clean Air Act Requirements

This chapter describes how Imperial County fulfils the CAA requirements for RFP, quantitative milestones, contingency measures, and transportation conformity.

6.1 Reasonable Further Progress (RFP)

Chapter 5 discusses how the District's control strategy meets the RACT, RACM, and ARM requirements of the CAA and presents the implementation schedule for newly proposed control measures. CAA Sections 172(c)(2) and 189(c) require attainment plans to demonstrate that an area's control strategy provides for reasonable further progress towards attainment of the NAAQS. The intent of this requirement is to ensure that areas will not delay implementation of emission control programs until immediately before the attainment deadline.

Per the 2016 $PM_{2.5}$ Implementation Rule, a Moderate nonattainment area demonstrates RFP by first projecting the emissions by pollutant (i.e., direct $PM_{2.5}$ and significant $PM_{2.5}$ precursors) that are expected to be achieved after the control measures have been implemented within the nonattainment area. At a minimum, these emissions need to be estimated for each quantitative milestone year. For Moderate areas, these quantitative milestones occur at 4.5 years and 7.5 years after the designation of the area. Since Imperial County was designated Moderate nonattainment in April 2015, its milestones occur in October 2019 and 2022. As shown previously, Table 5-11 summarizes key elements pertinent to an RFP analysis including the schedule for adoption and implementation of RACM and ARM, the affected pollutants, implementing agency, and the expected emission reductions from each measure in each quantitative milestone year.

One way Moderate nonattainment areas seeking approval under CAA Section 179(B) can demonstrate RFP is by showing generally linear emission reductions towards the full amount of reductions that will be achieved by the attainment year (i.e., the amount that reflects implementation of all of the control measures identified as RACT, RACM, and ARM for the entire period of the applicable attainment plan). This can be demonstrated by comparing the projected emissions at the milestone years against a linear interpolation of the emissions reductions between the baseline year (2012) and the attainment year (2021). This analysis, limited to direct $PM_{2.5}$[43] is tabulated in Table 6-1 and depicted graphically in Figure 6-1, and demonstrates that the projected emissions in the milestone years are below the linear trend line. This analysis combined with the information presented in Table 5-11 demonstrates that the Imperial County $PM_{2.5}$ Nonattainment Area meets the RFP requirements of the CAA as interpreted by the 2016 $PM_{2.5}$ Implementation Rule.

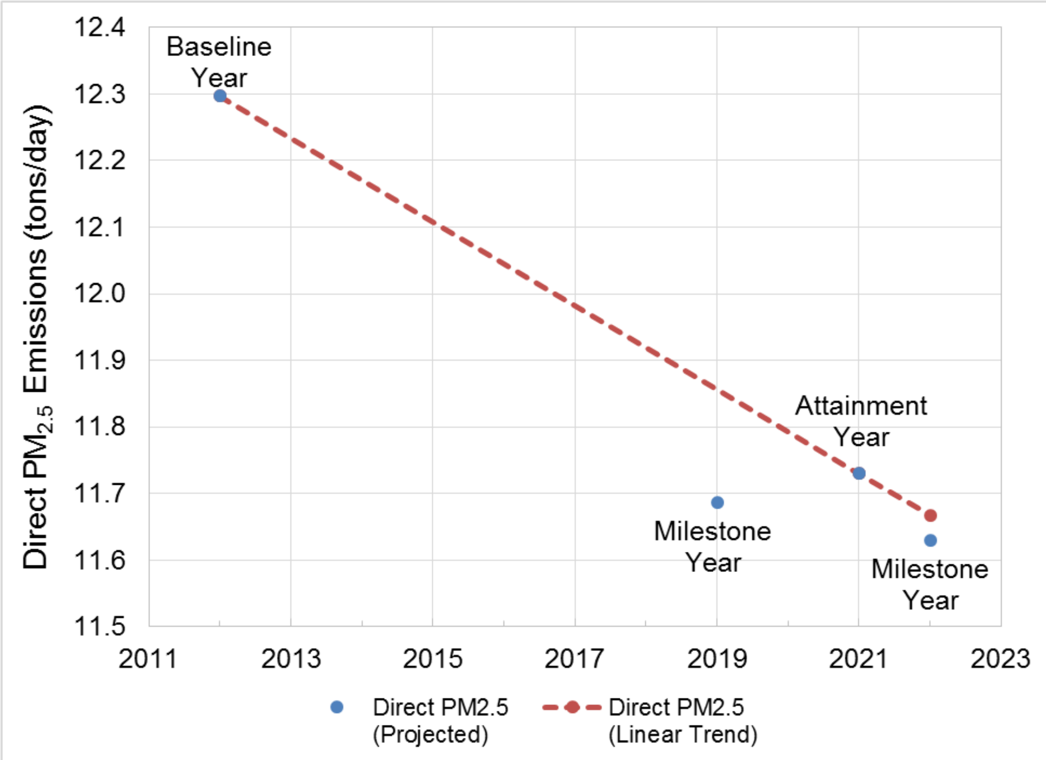
[43] As discussed in Section 3.17, CARB performed a comprehensive precursor demonstration to determine whether emissions of a particular $PM_{2.5}$ precursor significantly contribute to $PM_{2.5}$ levels in the Imperial County $PM_{2.5}$ Nonattainment Area. Ultimately, this demonstration showed that none of the four $PM_{2.5}$ precursors significantly contribute to $PM_{2.5}$ levels in Imperial County; therefore, the District isn't required to assess these pollutants for RFP.

Table 6-1. Reasonable Further Progress Demonstration for the Imperial County $PM_{2.5}$ Nonattainment Area (Annual Emissions Inventory, Tons per Day)

	2012	2019	2021	2022
	Baseline Year	Milestone Year	Attainment Year	Milestone Year
Direct $PM_{2.5}$ (Projected) [1]	12.2967	11.6866	11.7303	11.6292
Direct $PM_{2.5}$ (Base Inventory) [2]	*12.2967*	*11.6873*	*11.7325*	*11.6321*
Direct $PM_{2.5}$ (Condensable) [2,3]	*0.0947*	*0.1045*	*0.1086*	*0.1100*
Direct $PM_{2.5}$ (Filterable) [2,3]	*11.0289*	*10.5312*	*10.5705*	*10.4647*
Direct $PM_{2.5}$ RACM Reductions [4]	*0.0000*	*0.0007*	*0.0020*	*0.0027*
Direct $PM_{2.5}$ ARM Reductions [5]	*0.0000*	*0.0000*	*0.0002*	*0.0002*
Direct $PM_{2.5}$ (Linear Trend) [6]	12.2967	11.8561	11.7303	11.6673
Difference	--	- 0.1695	--	- 0.0381
Milestone Met?	--	Yes	--	Yes

Notes:
Values may not add up due to rounding.
[1] Projected values represent the base inventory values with the reductions from RACM and ARM incorporated.
[2] Inventory values taken from Tables 3-8a through 3-11b.
[3] Filterable and condensable emissions are a subset of the total $PM_{2.5}$ base inventory. Note, the breakdown of filterable and condensable components is not available for all source categories.
[4] RACM reductions are equivalent to the estimated reductions from the NSPS Certification wood burning fireplaces and wood burning heaters rule (see Table 5-2).
[5] ARM reductions are equivalent to the estimated reductions from the wood burning fireplaces and wood burning heaters curtailment rule (see Table 5-4).
[6] Values in 2019 and 2022 were linearly interpolated and extrapolated (respectively) from the projected $PM_{2.5}$ values in 2012 and 2021.

Figure 6-1. Reasonable Further Progress Demonstration for the Imperial County $PM_{2.5}$ Nonattainment Area (Annual Emissions Inventory, Tons per Day)



6.2 Quantitative Milestones

As part of the RFP demonstration, plans for Moderate nonattainment areas must include a set of quantitative milestones in order to maintain compliance with Section 189(c)(1) of the CAA. These demonstrations are to be completed by specific dates occurring in what are known as "milestone years". As discussed in Section 6.1, for Imperial County these milestones occur in October 2019 and 2022.

The quantitative milestones for this Plan involve two new Imperial County rules designed to implement control measures and reduce emissions of $PM_{2.5}$. The following is a description of these proposed rules, which are currently being developed by ICAPCD:

- Proposed Wood Burning Fireplace and Wood Burning Heaters Rule - NSPS Certification - requires new wood burning fireplaces and wood burning heaters to comply with NSPS certification requirements in effect at the time of installation.
- Proposed Wood Burning Fireplace and Wood Burning Heaters Rule - Curtailment - prohibits residential wood burning combustion in the city of Calexico on days forecasted to exceed 35 $\mu g/m^3$ at the Calexico monitor.

Once implemented, these rules will lead to reductions of $PM_{2.5}$, eventually resulting in lower ambient $PM_{2.5}$ concentrations. Together with inventory reporting, demonstration of the adoption and implementation of these rules serves as a quantifiable way for measuring progress towards attainment of the $PM_{2.5}$ NAAQS. Each of these rules is scheduled to be adopted in 2018, with implementation beginning in 2019 for the NSPS Certification Rule and 2020 for the Curtailment Rule.

The first quantitative milestone will involve the adoption and implementation of the NSPS Certification Rule and adoption of the Curtailment Rule. The District will report on this milestone in a document which it will submit to the USEPA prior to January 15, 2020 (i.e., within 90 days of the first milestone date, October 15, 2019). The District will have achieved the first quantitative milestone if it can report that it adopted the two rules in or before December 2018 and implemented the NSPS Certification Rule prior to April 15, 2019.

The second quantitative milestone will involve the implementation of the Curtailment Rule. The District will report on this milestone in a document which it will submit to the USEPA prior to January 15, 2023 (i.e., within 90 days of the second milestone date, October 15, 2022). The District will have achieved the second quantitative milestone if it can report that implementation of the Curtailment Rule began in 2020, as described in the control measures.

6.3 Contingency Measures

CAA Section 172(c)(9) requires an available set of contingency measures in the event that a nonattainment area fails to meet RFP or fails to make attainment. For the Imperial County $PM_{2.5}$ Nonattainment Area, an attainment contingency is not required because the area is seeking approval under CAA Section 179(B). Furthermore, it is important to note that because the County is submitting a comprehensive precursor demonstration showing that precursor emissions do not significantly contribute to $PM_{2.5}$ levels that exceed the standard in the area, the County is not required to develop contingency measures pertaining to those precursors.

The 2016 $PM_{2.5}$ Implementation Rule presents the various requirements for RFP contingency measures. Per the 2016 $PM_{2.5}$ Implementation Rule, if triggered, contingency measures must be able to be implemented without further action by the County, State, or USEPA. To ensure this, the contingency measures must be approved and fully adopted as part of an area’s attainment plan submission. Moreover, the submission must contain trigger mechanisms for the contingency measures and must demonstrate the schedule for implementation. For this Plan, the contingency provisions will be triggered within 60 days following a determination by the Administrator that the area has failed to:

1) Meet a RFP requirement in this Plan;
2) Meet a quantitative milestone in this Plan; or
3) Submit a quantitative milestone report.

In addition, approximately one year’s worth of reductions must be provided with the submitted contingency measures. This reduction is determined by the overall level of reductions needed to demonstrate attainment divided by the number of years from the baseline year to the attainment year. Alternately, in Imperial County’s case, the reduction must be equal to one year’s worth of emission reductions proportional to the overall amount of emission reductions that are to be achieved between the baseline and attainment years as part of RFP and shown in Table 6-1. The total amount of emission reductions between these years is 0.57 tons/day. When divided by the nine years between the baseline year and attainment year, the result is 0.063 tons/day or 22.3 tons/year. This is the amount Imperial County must meet for RFP contingency.

The RFP contingency measures must all be technologically and economically feasible to determine that they are reasonable measures for sources in the area, ideally exceeding the RACM/RACT control measure criteria. To provide for an approximate equivalent of one year's worth of emissions reductions or air quality improvement, an area may combine several measures, such as placing reasonable controls on sources outside the nonattainment area and implementing BACM/BACT early on select sources inside the area, along with adopting other identified measures.

To satisfy the SIP requirement for RFP contingency, the District explored various options for measures to implement in order to achieve direct $PM_{2.5}$ emissions reductions. After performing thorough research and calculations for reduction estimates for potential contingency measures with CARB and USEPA staff, the District identified a measure that meets all contingency measure requirements and would achieve at least one year's worth of reductions if implemented. For this contingency measure, the District proposes to amend Rule 804, *Open Areas,* to include a provision that would expand the rule's applicability criteria if contingency conditions are triggered under this Plan. Rule 804 regulates fugitive dust emissions by requiring landowners of open areas to implement BACM or Alternative BACM on plots exceeding 3.0 acres for rural areas or 0.5 acres for urban areas and containing at least 1,000 square feet of disturbed surface area. Since areas subject to Rule 804 are presumably already controlled to BACM levels, one way to effect further reductions is by expanding the applicability criteria. Under this contingency measure, the District would expand Rule 804 applicability to include all rural open areas containing at least 1,000 square feet of disturbed surface area.

The District performed an analysis to estimate what magnitude of reductions would be possible if this contingency measure were implemented. Using land parcel size data obtained from the Imperial County Assessor's Office, the total acreage of vacant rural parcels less than 3.0 acres in size in the $PM_{2.5}$ nonattainment area was estimated to be 529 acres. With this acreage the District estimated the potential $PM_{2.5}$ emissions from these areas using a method derived from CARB's *Windblown Dust - Unpaved Roads* guidance.[44] This method includes an equation with various input parameters, such as soil erodibility and surface roughness, which calculates a dust emission factor. This factor is then applied to the acreage of disturbed surfaces to estimate the total emissions of windblown dust. The potential reductions to be achieved through the expansion of Rule 804 applicability were estimated using the previous composite control factor of 70 percent.[45] This analysis found that this contingency measure would result in emission reductions of at least

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[44] CARB. 1997. Windblown Dust – Unpaved Roads. Section 7.13. Updated August 1997. Available at: https://www.arb.ca.gov/ei/areasrc/fullpdf/full7-13.pdf. Accessed: March 2018.

[45] The 70 percent composite control factor is from the "Final BACM Technological and Economic Feasibility Analysis" portion of the 2003 San Joaquin Valley APCD PM_{10} SIP and was used in ICAPCD's 2005 BACM Report titled, "Draft Final Technical Memorandum – Regulation VIII BACM Analysis" as well as ICAPCD's 2009 PM_{10} SIP.

0.088 tons $PM_{2.5}$ per day. This estimate exceeds the required one year of emission reductions (0.063 tons per day), thus satisfying contingency measure requirements. The details regarding this analysis as well as the sources used to support it are provided in Appendix D.

To further bolster the contingency strategy in this Plan, the District identified an additional contingency measure that would involve lowering the curtailment threshold for the Wood Burning Fireplaces and Wood Burning Heaters Curtailment Rule**.** As discussed previously in Chapter 5, Imperial County is proposing a new rule as ARM that will prohibit/curtail the combustion of wood or solid-fuel products in any wood-burning device in the city of Calexico during a curtailment period. Under the rule, the curtailment period would be defined as any period when $PM_{2.5}$ levels are forecast to exceed 35 $\mu g/m^3$ at the Calexico monitor. The District is proposing to include a provision in the rule that if contingency conditions are triggered, the curtailment threshold would be lowered to 30 $\mu g/m^3$ and the curtailment area would expand to include the entire County. The District estimates that an additional 0.0011 tons per day may be reduced when this contingency measure is implemented (see Table D-2a in Appendix D).

The District decided to pursue this additional contingency measure because additional wood burning curtailment would prove beneficial to the air quality in and around Calexico if contingency measures become necessary. Due to its proximity to the international border with Mexico, the southern part of Imperial County can be adversely influenced by the transport of $PM_{2.5}$ emissions across the border, resulting in exceedances caused by international transport. This is especially true for the city of Calexico as it borders the large metropolis of Mexicali, Mexico. During the colder winter months, biomass burning by the larger Mexicali population (and smaller Calexico-area population) is particularly pronounced, and the wood burning curtailment contingency measure would work to reduce this localized impact. Together with the Rule 804 contingency measure, reductions are estimated to equal at least 0.089 tons per day.

6.4 Transportation Conformity

Section 176(c) of the CAA establishes transportation conformity requirements that are intended to ensure that transportation activities do not interfere with air quality progress. The CAA requires that transportation plans, programs, and projects that obtain federal funds or approvals *conform to* applicable SIPs before being approved by a Metropolitan Planning Organization (MPO). Conformity to a SIP means that proposed activities must not:

1) Cause or contribute to any new violation of any standard,
2) Increase the frequency or severity of any existing violation of any standard in any area, or
3) Delay timely attainment of any standard or any required interim emission reductions or other milestones in any area.

A SIP analyzes the region's total emissions inventory from all sources for purposes of demonstrating RFP, attainment, or maintenance. The portion of the total emissions inventory from on-road highway and transit vehicles in these analyses becomes the "motor vehicle emissions budget." 46 Motor vehicle emissions budgets are the mechanism for ensuring that transportation planning activities conform to the SIP. Budgets are set for each criteria pollutant or its precursors, and it is set for each RFP milestone year and the attainment year. Subsequent transportation plans and programs produced by transportation planning agencies are required to conform to the SIP by demonstrating that the emissions from the proposed plan, program, or project do not exceed the budget levels established in the applicable SIP.

6.4.1 Significance of $PM_{2.5}$ Precursors and Components for Transportation Conformity

USEPA has promulgated rules in 40 CFR Part 93 that implement the conformity section of the CAA. Section 93.102(b) of the conformity rule identifies the pollutants/precursors that in the budget setting process are presumed to be significant for a particular NAAQS and must be addressed. Pollutants and/or precursors presumed insignificant only need to be addressed in the budget process when the SIP finds them significant. For $PM_{2.5}$, the only pollutants/precursors presumed significant are directly emitted $PM_{2.5}$ (exhaust, tire and brake wear), and NO_X from on road motor vehicles.

Section 93.102(b)(2)(v) of the conformity rule identifies VOC, SO_X, and NH_3 as $PM_{2.5}$ precursor pollutants that are presumed insignificant unless the SIP makes a finding that the precursor is significant. In addition, Section 93.102(b)(3) identifies re-entrained road dust from paved and unpaved roads as $PM_{2.5}$ emissions that are presumed insignificant unless the SIP makes a finding of significance. While the applicability section of the rule does not address fugitive dust from road construction specifically, Section 93.122(f) of the rule does indicate that the interagency consultation process should be used during the development of $PM_{2.5}$ SIPs to determine when construction emissions are a significant contributor.

6.4.2 Determining the Need for Motor Vehicle Emissions Budgets for On-Road NOx Emissions

Section 93.102(b)(2)(iv) allows the USEPA Regional Administrator and the director of the state air agency to make a finding if transportation related emissions of NO_X are a significant contributor to the $PM_{2.5}$ nonattainment area problem, and thus, if NO_X motor vehicle emissions budgets should be established. This Plan finds that NO_X emissions are an insignificant contributor to $PM_{2.5}$ air quality in the Imperial County $PM_{2.5}$ Nonattainment Area. This finding of insignificance for NO_X is supported by the sensitivity analysis conducted through modeling found in Section 3.17 of this Plan.

In 2012, the base year of the attainment plan, emissions of NO_X from on road motor vehicles contribute 5.3 tons per day (tpd) or about 37 percent of the region's NO_X inventory. In the

[46] Federal transportation conformity regulations are found in 40 CFR Part 51, Subpart T – Conformity to State or Federal Implementation Plans of Transportation Plans, Programs, and Projects Developed, Funded or Approved Under Title 23 U.S.C. of the Federal Transit Laws. Part 93, Subpart A of this chapter was revised by the USEPA in the August 15, 1997 Federal Register.

attainment year of 2021, the contribution of on road NO_X is reduced to 2.6 tpd or about 27 percent. Table 1 below summarizes the projected trends in NOx emissions and the projected contribution of on road motor vehicles to the nonattainment area's emissions inventory.

Table 6-2. 2012-2022 Mobile Source NO_X Emissions and Contribution to Total NO_X in the Imperial County $PM_{2.5}$ Nonattainment Area (tons per day) (Annual)

Source	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total NOX	14.2	13.4	12.5	12.0	11.7	11.3	10.8	10.2	10.0	9.6	9.2
On-Road NOX	5.3	4.8	4.2	3.9	3.7	3.4	3.2	2.9	2.8	2.6	2.4
Percent Contribution of On-Road	37%	36%	34%	32%	31%	30%	30%	28%	28%	27%	26%

Source: CEPAM v1.05

Although Table 6-2 suggests that on-road emissions of NO_X are significant, the precursor sensitivity analysis in Section 3.17 demonstrates that NO_X is not a significant contributor to $PM_{2.5}$ air quality in the Imperial County $PM_{2.5}$ Nonattainment Area.

To evaluate the impact of reducing emissions of different $PM_{2.5}$ precursors on the base year (2012) $PM_{2.5}$ design value, a series of model sensitivity simulations were conducted, where emissions of the precursor species in Imperial County were reduced by 70 percent from the base year emissions. The precursor analysis found that a 70 percent decrease in NO_X only reduced the 2012 annual design value at Calexico 0.05 $\mu g/m^3$. For this reason, attainment of the NAAQS is not dependent on any NO_X controls in this Plan. Therefore, the sensitivity analysis demonstrates that NO_X is an insignificant precursor in the Imperial County $PM_{2.5}$ Nonattainment Area for the annual $PM_{2.5}$ NAAQS and this Plan does not set NO_X emissions budgets for transportation conformity. More detail regarding the insignificance of NO_X can be found in Section 3.17.

6.4.3 Significance of Fugitive Emissions of $PM_{2.5}$

As mentioned earlier, Section 93.102(b)(3) identifies re-entrained road dust from paved and unpaved roads as $PM_{2.5}$ emissions that are presumed insignificant unless the SIP makes a finding of significance. While the applicability section of the rule does not address fugitive dust from road construction specifically, Section 93.122(f) of the rule does indicate that if the $PM_{2.5}$ SIP determines that all construction emissions are a significant contributor that fugitive dust from road and transit construction should be included in the conformity analysis, thus be included in the area's Motor Vehicle Emissions Budget.

This Plan makes no finding of significance for fugitive road construction dust; however does find that re-entrained dust from roads are significant (see Table 6-3).

Table 6-3. Mobile $PM_{2.5}$ Dust Categories Contribution to Total $PM_{2.5}$ Emissions (tons per day) (Annual)

Category	2012	% of PM2.5	2021	% of PM2.5
Paved Road Dust	0.12	1%	0.16	1%
Road Construction Dust	0.03	0%	0.05	0%
Tire Wear, Break Wear, Exhaust	0.32	3%	0.11	1%
Unpaved Road Dust-City/County	2.06	17%	1.48	13%

Source: CEPAM v1.05

6.4.4 Re-entrained Road Dust

Re-entrained road dust emissions from roads are deemed significant in the Imperial County $PM_{2.5}$ Nonattainment Area based on the $PM_{2.5}$ emissions contribution from roads, which comprise almost 18 percent of the $PM_{2.5}$ emissions in the region in 2012, or 2.18 tpd. Furthermore, because this Plan incorporates control measures for fugitive emissions from roads and the contribution of this category contributes a large share of to the $PM_{2.5}$ inventory in the region, re-entrained dust from roads is considered significant for conformity purposes. Therefore, this Plan establishes transportation conformity emissions budgets for direct $PM_{2.5}$ from tire wear, brake wear and exhaust, and paved and unpaved road dust in the Imperial County $PM_{2.5}$ Nonattainment Area. Table 6-4 below shows the trend for direct $PM_{2.5}$ from tire wear, brake wear and exhaust, and paved and unpaved road dust in the Imperial County $PM_{2.5}$ Nonattainment Area for 2012, 2019, and 2022.

Table 6-4. 2012, 2019, and 2022 $PM_{2.5}$ Emission Inventory Trend for Roads in the Imperial $PM_{2.5}$ Nonattainment Area (tons per day) (Annual)

Category	2012	2019	2022
Paved Road Dust	0.12	0.15	0.17
Unpaved City-County Road Dust	2.06	1.48	1.35
Tire Wear, Brake Wear, and Exhaust	0.32	0.11	0.11

Source: CEPAM v.1.05

6.4.5 Motor Vehicle Emission Budgets

Based on the findings above, this Plan makes no findings of significance for NO_X, VOC, SO_X, NH_3 or fugitive road construction dust; however does find that re-entrained road dust is significant. Conformity budgets are being established for $PM_{2.5}$ for the years 2019 and 2022 (Table 6-5). The $PM_{2.5}$ budget includes direct $PM_{2.5}$ from tire wear, brake wear and exhaust, and paved and unpaved road dust from the $PM_{2.5}$ emissions inventory. It is important to note that the regional road dust controls (Rules 800, 803, 804, and 805) will continue to provide additional emission reductions into the future.

Table 6-5. Transportation Conformity Budgets ($PM_{2.5}$ tons per day) (Annual)

2012	2019	2022
2.6	1.8	1.7

Source: CEPAM v.1.05

7 Border Strategic Concepts

7.1 Introduction

This chapter discusses the ICAPCD's overall involvement in working cooperatively with counterparts from Mexico to develop emission reductions strategies and projects for air quality improvement at the border and to provide public information and education and a forum to border residents. In August 2012, the U.S. and Mexico signed the U.S.-Mexico Environmental Program Border 2020. Border 2020 is a cooperative effort between the USEPA, Mexico's SEMARNAT, the four U.S. border states (Texas, New Mexico, Arizona, and California), and the six Mexican border states (Tamaulipas, Nuevo León, Coahuila, Chihuahua, Sonora, and Baja California), plus 26 U.S. border tribes. The initiative is to improve the environment by focusing on cleaning the air, providing safe drinking water, reducing the risk of exposure to hazardous waste, and ensuring emergency preparedness along the U.S.-Mexico border. By improving the environment, both countries seek to protect the health of the people who live along the international border.

The two countries strive to achieve these goals through local input from states, local governments, and citizens. Within the Mexicali and Imperial Valley area, the Air Quality Task Force (AQTF) has been organized to address those issues unique to the border region known as the Mexicali/Imperial air shed. The AQTF membership includes representatives from federal, state and local governments from both sides of the border, as well as representatives from academia, environmental organizations, and the general public. This group was created to promote regional efforts to improve the air quality monitoring network, emission inventories and air pollution transport modeling development, as well as the creation of programs and strategies to improve air quality. Air quality improvement programs are used as a valuable resource by the local environmental managers to determine connections between air quality, land use, communications infrastructure, and economic development issues.

Following is a brief summary of some of the projects in which the ICAPCD, in conjunction with the AQTF, CARB and USEPA, participates to address or evaluate emissions at the border and educate the communities on the impact of air pollution in this region.

7.1.1 Web-Based Air Quality and Health Information Center

ICAPCD and CARB, in cooperation with the USEPA, operate a web-based air quality and health information center for Imperial County (available at: http://www.imperialvalleyair.org/). Through this project, the community is able to take advantage of the real-time data collected by the CARB- and ICAPCD-operated monitoring stations, including data for ozone and particulate matter (i.e., $PM_{2.5}$ and PM_{10}). The website allows residents to sign up to receive email, text, or push notifications (via the Imperial Valley Air Quality mobile app) when air quality in the region reaches unhealthy levels. Features of the mobile app include a forecast discussion with related weather information, an explanation of the Air Quality Index (AQI), a "locate me" GPS based notification, and an identification of the cities where air monitoring stations are located. The overall purpose of this project is to enable schools and after-school programs, as well as others in the county, to make informed choices to reduce their exposure to air pollutants and to be prepared to use prescribed treatments, such as inhalers, when air pollution reaches levels that could adversely affect their asthma or other respiratory ailments.

7.1.2 AQI Advertisement

Asthma is a common health issue in Imperial County. Education in daily air quality conditions is a great need for the community. In order to promote air quality awareness and protection, the ICAPCD established an AQI Advertisement Campaign with the purpose of educating and alerting the community of the daily particulate risk levels. The campaign serves as a visual communication method by utilizing a marquee at a highly trafficked area of the county as well as a local radio and television station which includes website displays of AQI alerts. The advertisement is based on AQI colors that are easily understood by all ages. Overall, the goal of the program is to alert the community of daily air quality conditions to protect children and adults prone to asthma.

AQI Marquee at Imperial Valley Mall is an electronic billboard that features advertising displays to the north and south. The billboard system allows for the customer to change the advertisement to display real-time data, if need be. For example, this system has the capability to display the AQI and can be used to display an AQI alert. In addition, the marquee may be modified any time of the day to provide other air quality information to residents in Imperial County and Mexicali who visit the Imperial Valley Mall. Such notifications may include ICAPCD board hearings, workshops, and incentive programs as well as AQTF events.

AQI Media Advertisements include a one-year advertisement agreement with Entravision/Univision, a local high–rated and frequently-viewed television station. Viewers will be informed of the air quality forecast, the current AQI, and the AQI website, while the sponsorship logo (i.e., the USEPA), telephone, and website will be displayed throughout the segment which occurs twice a day during the morning and evening news. The AQI Media Advertisements also include a one-year agreement with high-rated radio station which will announce the AQI, air quality forecast, and Imperial County AQI website[47] three times a day for 30 seconds. This package deal also includes a one-year advertisement on three local radio and television websites.

7.1.3 Mexicali and Imperial County Educational Media Campaign

As stated in Appendix A, the majority of violations of the $PM_{2.5}$ NAAQS occurring at the Calexico monitoring station occur during the months of December and January. It is during these months when continual stagnant conditions with light winds predominate in this region. These conditions, coupled with the tradition in Mexicali of burning wood, tires, etc. for warmth during cold nights, lead to violations of the PM_{10} and $PM_{2.5}$ standards in Calexico. Uncontrolled open burning in Mexicali is primarily a cultural problem. Also, it is a tradition to use fireworks during the winter holidays in Mexico, which exacerbates the air pollution problem in this area.

Since this problem is primarily cultural, it is imperative that all members of Mexicali's community, in particular children and young adults, learn about the consequences of open burning of tires, wood, fireworks, etc. to instil a change of attitude in the community with respect to this subject. This is expected to be accomplished through an ongoing educational media campaign targeting

47 http://www.imperialvalleyair.org/

the city of Mexicali, so that all age groups can understand the air quality problem and be informed of how they can help prevent or minimize air pollution in the Mexicali region.

Therefore, through a collaborative and cooperative effort between the Border 2020 program, the USEPA, and the Border Environmental Cooperation Commission (BECC), the ICAPCD and the Imperial Valley-Mexicali AQTF through the Border 2020 program have been funding a “no burn” radio and television Environmental Educational Media Campaign (“Campaign”) to help educate the Mexicali community concerning the impacts from open burning upon the regional air quality. The Campaign encourages a “no burn” mentality and promotes awareness for the wellbeing of the region’s health and environment. Community education and awareness on the management and prevention of burning is a shared public-private responsibility. As such, ICAPCD is the lead agency for this Campaign, and the Secretariat of the State of Baja California is focused on the media portion of the project. The radio and television Campaign objectives are the following:

- Educate the community regarding the status of the air quality in the region and the consequences of open burning of tires, wood, fireworks, etc.;
- Educate young adults with the goal to create environmental advocates who care for and respect the environment;
- Raise public awareness around the serious consequences of open burning of tires, wood, fireworks, etc. on regional air quality;
- Work towards creating a “no burn” mentality; and
- Improve community leadership involvement.

The media slogan, ***“Because the future is in your hands: Ambientalizate! (Environmentalize)”*** is the dominant element of the Campaign. The Campaign is focused on days that are likely to violate the federal health standard for air quality, traditionally during the holiday season in December and January. Therefore, the media transmissions are aired in phases to capture the period of most pollution. There are three audience profiles the Campaign targets: children in kindergarten to sixth grade, young adults in junior high to high school and the general public.

The first step of the Campaign targeted the education of the health and air quality impacts resulting from the burning of fireworks, tires, and wood. Because of the deeply entrenched cultural tradition behind the practice of open burning and the use of fireworks during holiday celebrations, expectations are that a “no burn” mentality will be difficult to achieve. However, again, there is a need to disseminate a complete awareness to the affected community of the health and air quality impacts that occur as a result of current cultural traditional practices. The affected community, in turn, can then understand the long-term harm that will continue should these cultural traditional practices not change.

The ICAPCD started implementing this Campaign in 2011. The Campaign media advertisements have a series of five 20-second television and radio spots that are geared towards the “no burn” mentality. For example, one spot emphasizes the health impacts caused from the burning of wood and tires. Similarly, another spot emphasizes the health impacts caused by fireworks. The ICAPCD is committed to yearly implementation of the Environmental Educational Media

Campaign, as funding allows. The Campaign has opened many avenues of communication with Mexicali's community and it carries tremendous power to educate all audiences.

7.1.4 Vehicle Idling Emissions Study at Calexico East and Calexico West Ports of Entry (POE)

Reducing emissions of PM and NO_X from idling vehicles at ports of entry is one of the most important air quality challenges facing the Imperial County and Mexicali region. Even with standards taking effect over the next decade for idling vehicles, millions of vehicles will continue to emit large amounts of NO_X, PM, and air toxics, which contribute to serious public health problems.

It is important to understand the impacts and to evaluate the amount of air emissions generated by idling vehicles at the Calexico East and Calexico West ports of entry (POE). On behalf of the AQTF, in 2014, the ICAPCD was selected as a grantee by BECC to study border idling. The ICAPCD hired a consulting firm to develop an analysis with two essential elements. The first element was to determine the vehicle idling impacts at both POE. The second element, crucial to any air quality improvement, was the identification of emission reduction strategies that U.S.-Mexican planning agencies could implement at both POE to reduce impacts on the general population. Estimating emissions from idling vehicles and identifying potential control strategies can be helpful in securing organizational support for federal, state, and local governments on both sides of the border. Overall, this project estimated PM and NO_X emissions from northbound idling vehicles waiting at two POE and identified emission reduction strategies (with accompanying PM and NO_X reductions) that U.S. and Mexican planning agencies could implement at the POE.

7.1.4.1 Results

The first phase of this study focused on the collection of real-world data to better characterize and understand the emissions and causes of delay at the POE. The second and third phases of this study focused on estimating seasonal emissions of $PM_{2.5}$, ROG, and NO_X at the POE under existing (2014) conditions and with several strategies to reduce those emissions. In addition, to analyze existing conditions and an idealized no POE delay scenario, seven emission reduction scenarios were studied:

- Phase 1 of the Calexico West POE reconstruction project;
- Phase 2 of the Calexico West POE reconstruction project;
- Use of California fuel in Mexicali;
- A reduction in empty general-purpose truck trips;
- Replacing 10 percent of general-purpose truck trips to FAST truck trips;
- Streamlining commercial crossing by combining the Aduanas and U.S. Customs and Border Protection (CBP) primary inspections; and
- The Section 559 Proposal to expand the Calexico East POE.

Table 7-1. POE Study Results Summary

Best Management Practice – Emission Reduction Strategy	Number of Privately Owned Vehicles That Would Need to be Removed or Subjected to a Scrappage Program to Achieve Similar Emission Reductions			Control Strategy Rank by Pollutant	
	NOx	$PM_{2.5}$	ROG	NOx and $PM_{2.5}$	ROG
Calexico East Section 559 Proposal, with Calexico West Phase 1 POE Project	634 vehicles	469 vehicles	1371 vehicles	1	2
Combine Aduanas and CBP Primary	469 vehicles	366 vehicles	90 vehicles	2	5
Calexico West Phase 1 and 2 POE Project	315 vehicles	229 vehicles	1310 vehicles	3	3
Calexico West Phase 1 POE Project	98 vehicles	68 vehicles	681 vehicles	4	4
Shift 10 percent of Commercial General-Purpose to FAST	80 vehicles	68 vehicles	19 vehicles	5	6
Reduction in Empty Commercial General-Purpose Volume	33 vehicles	26 vehicles	6 vehicles	6	7
California Fuel in Mexicali	0 vehicles	0 vehicles	1638 vehicles	7	1

The results indicate that border delay accounts for about 63 percent of the ROG emissions, 46 percent of the NO_X emissions, and 53 percent of the $PM_{2.5}$ emissions from northbound vehicles crossing into the United States on an annual basis. The emissions associated with border delay are equivalent to the TOG emissions from 2,700 passenger vehicles in Imperial County, the NO_X emissions from 4,400 passenger vehicles in Imperial County, and the $PM_{2.5}$ emissions from 3,450 passenger vehicles in Imperial County. The results above are shown as the equivalent number of privately owned vehicles in Imperial County that would need to be removed from the vehicle fleet to achieve the same air quality emissions benefit.

7.1.5 Program to Improve Air Quality in Mexicali 2011-2020

The Mexican government has developed ProAire, a very ambitious program to reduce air emissions in Mexicali. Reducing $PM_{2.5}$ emissions in Mexicali is crucial to the reduction of the transport of air emissions into Imperial County. The reduction of such transport of air emissions will greatly reduce the impact of poor air quality in both air sheds. The ICAPCD actively participated during the development of the air program for Mexicali, as an expert air quality agency, by reviewing and providing constructive comments through bi-national meetings such as the AQTF. It is worthy to note that neither ICAPCD, CARB, nor the USEPA has any jurisdictional authority over emission sources in Mexico. This program includes actions to reduce air emissions from different source categories.

The ProAire program represents a collaborative effort between the federal, state, and municipal governments, along with industry and the community to improve the quality of life in the Mexicali community and to reduce the risk of exposure to air pollution. This program identifies agricultural burning, paved and unpaved roads, and power generation as the main sources of direct $PM_{2.5}$ emissions in Mexicali. The program includes actions to reduce air emissions from these source categories, as follows:

- Regulating agricultural burning and developing a diagnosis of the current state of agricultural burning in Mexicali in order to establish the meteorological and size conditions under which agricultural burning can be allowed. In addition, establishing a model to incentivize reduction of agricultural burning and identifying other alternatives to agricultural burning. This program is projected to be implemented in 2019.
- Developing a strategy to reduce particulate emissions from paved and unpaved roads. This would involve evaluating potential sustainable paving techniques as well as identifying financial sources to implement and incentivize road paving programs. This program is projected to be implemented in 2020.
- Establishing agreements with power generation facilities to evaluate the significance of their air emissions on air quality and public health and to identify new actions to reduce and control their air emissions. The goal would be to implement these actions for every power generation facility in the Mexicali area. The ProAire program would also look to promote and develop renewable energy projects. This program is projected to be implemented in 2020.

8 Conclusion and SIP Checklist

8.1 Checklist of SIP Requirements and Conclusions

A checklist of the 2012 $PM_{2.5}$ NAAQS requirements pertinent to the 2018 Annual $PM_{2.5}$ SIP (as outlined both in the CAA Part D, Subpart 1, Section 172, Nonattainment Plan Provisions, and Subpart 4, Section 189, Plan Provisions and Schedules for Plan Submission) for Moderate nonattainment areas is presented in Table 8-1. As documented in Table 8-1, all SIP requirements applicable to the 2018 Annual $PM_{2.5}$ SIP have been successfully addressed.

Table 8-1. Clean Air Act Regulatory Requirements

General Requirements	CAA Citation	Description	2018 Annual $PM_{2.5}$ SIP
RACT/RACM	172(c)(1) and 189(a)(1)(C)	SIP provisions should provide for the implementation of reasonably available control measures (RACM), including at a minimum, reasonably available control technologies (RACT).	Chapter 5
RFP	172(c)(2)	SIP provisions should provide for reasonable further progress (RFP).	Section 6.1
Quantitative Milestones	189(c)(1)	SIP provisions should include quantitative milestones which are to be achieved every 3 years until the area is redesignated attainment and which demonstrate reasonable further progress.	Section 6.2
Contingency Measures	172(c)(9)	The SIP must contain contingency measures that must be implemented (without the need of additional rulemaking actions) in the event that the area fails to make reasonable further progress or to attain the NAAQS by the attainment date.	Section 6.3; attainment contingency not required for areas seeking approval under CAA Section 179(B).

Table 8-1. Clean Air Act Regulatory Requirements			
General Requirements	**CAA Citation**	**Description**	**2018 Annual $PM_{2.5}$ SIP**
Emissions Inventory	**172(c)(3)**	**The SIP must include a comprehensive, accurate, current inventory of actual emissions from all sources of the relevant pollutants in the area.**	**Chapter 3 presents $PM_{2.5}$ and $PM_{2.5}$ precursor inventories for the baseline year (2012), attainment year (2021), and two milestone years (2019 and 2022). Chapter 3 also includes a breakdown of condensable versus filterable $PM_{2.5}$ emissions.**
NSR	**172(c)(4-5) and 189(a)(1)(A)**	**The SIP must identify and quantify the emissions of pollutants with Section 173(a)(1)(B), from the construction and operation of major new or modified stationary sources in the area. The SIP must require permits for new or modified stationary sources.**	**Section 5.2.1**
Attainment Demonstration	**179(B)(a) and 189(a)(1)(B)**	**CAA provides the State with an option to demonstrate that a nonattainment area would meet the NAAQS "but for" emissions emanating from outside of the United States.**	**Chapter 4 and Appendix A demonstrates the Imperial County nonattainment area would be in attainment "but for" emissions from Mexico.**

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APPENDIX A
CLEAN AIR ACT SECTION 179(B) TECHNICAL DEMONSTRATION

CALIFORNIA AIR RESOURCES BOARD

FINAL

Clean Air Act Section 179B Technical Demonstration

Imperial County PM2.5 Nonattainment Area

January 5, 2018

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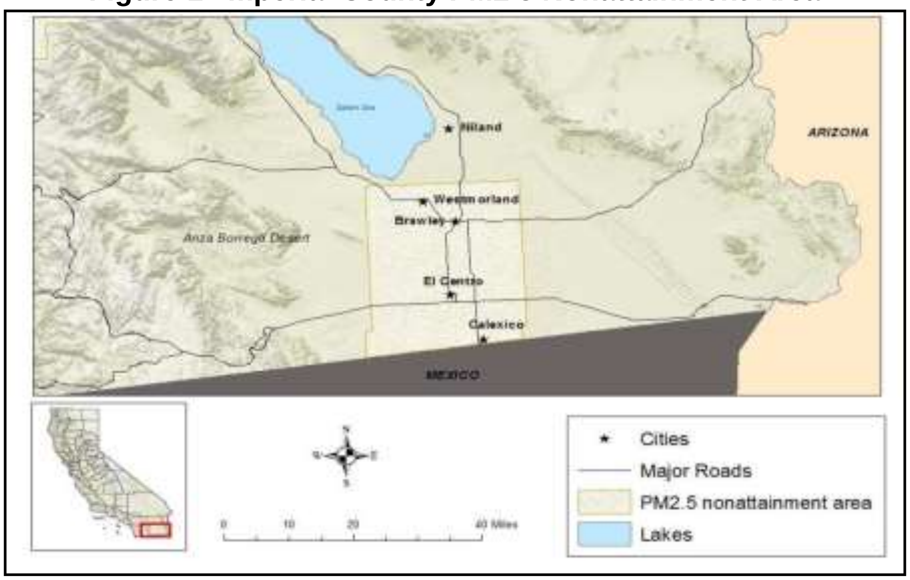
Appendices:

I. Overview

On December 18, 2014, the U.S. Environmental Protection Agency (U.S. EPA) designated the Imperial County PM2.5 (particulate matter less than 2.5 micrometers) nonattainment area (Imperial County PM2.5 NA) as nonattainment for the 12 μg/m^3 annual PM2.5 standard based on air quality data collected adjacent to the Mexico international border. The purpose of this analysis is to identify the origin of emissions impacting PM2.5 concentrations in the Imperial County PM2.5 NA next to the Mexico international border (Figure 1).

The Imperial County PM2.5 NA is an agricultural community located in the southeast corner of California, which shares its southern border with Mexicali, Mexico. The Imperial County PM2.5 NA includes three PM2.5 monitoring sites, located in the cities of Calexico, El Centro, and Brawley (south to north). These three cities are about the same size and, in general, have similar emission sources. In theory, due to their similarities, these PM2.5 monitors should record similar levels. Calexico is the only violating PM2.5 monitor in the Imperial County PM2.5 NA and records a PM2.5 design value (DV) almost twice that of the other two monitors.

Figure 1. Imperial County PM2.5 Nonattainment Area



Measured PM2.5 concentrations at sites in the Imperial County PM2.5 NA may be attributed to emissions originating from one or more of the following sources: emissions generated locally within Imperial County; emissions generated outside the U.S. and transported across international borders; and emissions generated in the U.S. and transported within California or across State lines. From an air quality perspective, Calexico and the Mexicali Metropolitan Area share a common air shed. Since the topography does not restrict air flow from either side of the border and both areas experience similar meteorology, Mexicali pollution impacts Calexico. The Calexico site is less than one mile from the international border and, according to U.S. EPA monitor siting criteria, represents air pollution of both Calexico and Mexicali.

The Mexicali Metropolitan Area has a population of close to 1,000,000 people as compared to the significantly smaller city of Calexico which has a population of 38,572 people (2010 U.S. Census). Figure 2 shows a nighttime aerial view of Calexico and Mexicali which highlights the large difference in size and population. Because of these differences, Mexicali emission sources on a daily basis can impact Calexico ambient PM2.5 concentrations. Emissions inventory data for Mexicali shows that Mexicali emissions are magnitudes higher than the emissions in the Imperial County PM2.5 NA.

Figure 2. . Mexicali and Calexico

This analysis provides technical documentation that in 2021 the Imperial County PM2.5 NA will have attained the annual PM2.5 standard of 12.0 μg/m^3 (micrograms per cubic meter) but for emissions emanating from Mexico. The Clean Air Act (Act) contains a specific provision in Section 179B for areas that are affected by the international cross-border transport of pollutants. Exceedances that occur due to international transport may cause violations of the standard; however, the Act recognizes that an area might not be able to demonstrate attainment due to cross-border transport but contains provisions to ensure an area is taking appropriate actions and implementing local controls to decrease the impact of local emissions to protect public health.

Section 179B of the Act for international border areas indicates that a state implementation plan (SIP): "…shall be approved by the Administrator if—(1) [the implementation plan meets all applicable requirements other than the attainment demonstration requirement], and (2) the submitting state establishes…that the implementation plan…would be adequate to attain and maintain the…national ambient air quality standards (NAAQS) by the attainment date, but for emissions emanating from outside of the United States."[1]

[1] Clean Air Act Amendments of 1990: Public Law 101-549.

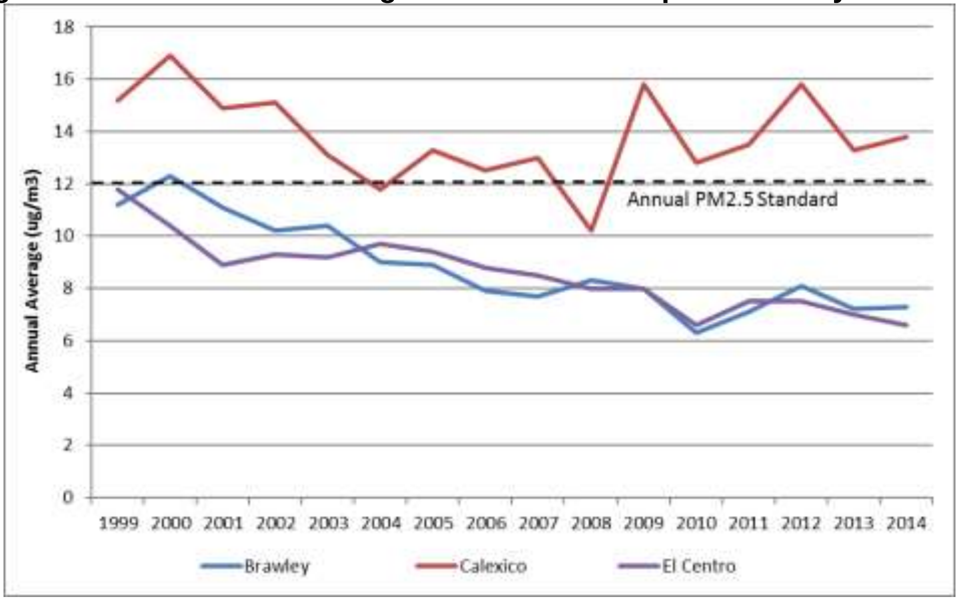
U.S. EPA guidance issued in 1994 therefore indicated that those border areas that provide a technical justification of attainment but for emissions from foreign sources are relieved of certain planning requirements including development of an attainment demonstration.[2] U.S. EPA guidelines on demonstrating that an area is in attainment but for emissions emanating from outside the United States identify the types of information that may be used in evaluating the impact of emissions from outside the U.S. on nonattainment areas. States may use one or more of the approaches based on the specific circumstances and the data available.

For this analysis, staff used all of the approaches mentioned in the guidance to evaluate the impact of Mexicali emissions on the Calexico PM2.5 monitor. Staff conducted various analyses on the monitoring data, meteorological conditions, and the emissions in the border region to evaluate the impacts of emissions emanating from Mexicali, Mexico on attainment of the annual PM2.5 standard. Staff also analyzed speciation data at Calexico and conducted a source apportionment analysis which tied the speciation data to certain sources that are present in both the Imperial County PM2.5 NA and Mexicali, Mexico. This apportionment method allowed for a recalculation of the annual PM2.5 DV when certain sources (specifically sources present in Mexicali, Mexico) were excluded from consideration. Air quality modeling was also conducted which demonstrated what the annual average PM2.5 DV would be at the Calexico PM2.5 monitor in 2021 if emissions from Mexicali, Mexico were reduced or eliminated completely.

Within the Imperial County PM2.5 NA, annual average PM2.5 trends indicate improving air quality in two of the three PM2.5 regulatory monitoring sites: El Centro and Brawley (Figure 3). Both El Centro and Brawley are north of Calexico, a U.S. border city adjacent to Mexicali, Mexico. As shown in Figure 3, Brawley and El Centro, similar to Calexico in size, population, and local emissions, have responded similarly to California control programs and air quality has improved as a result. However, in Calexico, air quality has not improved and remains above the federal annual average PM2.5 standard of 12.0 µg/m3.

[2] See 59 FR 42000-42002 (August 16, 1994).

Figure 3. PM2.5 Annual Average Trends for the Imperial County PM2.5 NA



*2008, 2009, 2011, and 2012 annual average data were incomplete at Calexico.

As detailed in the following analyses, the results support a conceptual model that identifies the type and location of emission sources that significantly contribute to elevated PM2.5 levels in the Imperial County PM2.5 NA. Considered together with air quality data and meteorological influences, the analyses in this demonstration indicate that, in 2021, the Imperial County PM2.5 NA will have attained the annual PM2.5 standard of 12.0 µg/m^3 but for emissions from Mexico.

II. Imperial County Border Region

The topography, climate, and emission sources in Imperial County and Mexicali provide a starting point in evaluating the transport of pollutants across the U.S.-Mexico border. Each of these factors contributes to conditions that facilitate the transport of direct PM2.5 and PM2.5 precursors (oxides of nitrogen (NOx), oxides of sulfur (SOx), reactive organic gases (ROG), and ammonia (NH_3)) from Mexico to the U.S. and, to a lesser extent, the transfer of pollutants from the U.S. to Mexico. The analyses in this technical demonstration focus on the transport of pollutants from Mexico to the U.S. within the border region and how that transport impacts the ability of Imperial County to attain the annual PM2.5 standard. As used in this document, the definition of the border region is limited to the area within the Imperial County PM2.5 NA and the area south of the border to include the City of Mexicali, Mexico.[3]

The Imperial Valley, which extends southward into the Mexicali Valley, is part of the Salton geological depression, an expansive area averaging approximately 70 feet below sea level and is bordered by the Peninsular Ranges and the Chocolate Mountain Range

[3] This definition is more focused than the definition referenced in the 1983 La Paz Agreement of 100 kilometers (62 miles) on either side of the international border. See https://www.epa.gov/international-cooperation/la-paz-agreement.

to the west and east, respectively. South of the border, the Sierra de los Cucapas Mountains lie to the southwest of Mexicali. These ranges act as barriers and channel airflow within the Imperial and Mexicali Valley facilitating the mixing and accumulation of pollution across the international border. The topography, coupled with common meteorology throughout the area, results in a single binational air shed for the region. Mountain valleys often enhance the formation of atmospheric temperature inversions and result in little or no mixing of trapped pollutants. This phenomenon is common in the Imperial Valley, particularly near the international border on nights with light winds. Inversions often occur over multiple days during the winter months resulting in PM2.5 exceedances of the 35 $\mu g/m^3$ 24-hour PM2.5 standard. Occasional high PM2.5 concentrations are also measured during the spring and summer months, contributing to nonattainment of the annual PM2.5 standard of 12.0 $\mu g/m^3$.

The climate of the border region is hot and arid with an average of less than three inches of rainfall per year.[4] These conditions exacerbate the generation of particulates from disturbed dry soil and may lead to violations of the PM2.5 NAAQS. Prevailing winds in the border region, particularly during the fall, winter, and early spring, are predominantly from the northwest. During the summer the winds shift and originate predominately from the southeast. From an air quality perspective, the border region near Calexico and Mexicali are contained within a common air shed and therefore, coupled with the topography of the region, often experience similar air quality.

In evaluating influences on air quality, the differences between the U.S. and Mexican sides of the international border are most pronounced in terms of emission sources. On the U.S. side, and within Imperial County, sources of direct PM2.5 emissions consist primarily of fugitive dust sources, including dust from unpaved roads and agricultural tilling, which are controlled by the District at a BACM (Best Available Control Measure) level. Analyses conducted for the Imperial County SIP for the 24-hour PM2.5 standard,[5] coupled with a review of the inventory data for the current plan, indicate that total emissions of NOx, SOx, ROG, PM2.5, and ammonia from Mexicali are higher on average than emissions from the Imperial County PM2.5 NA for the same source categories. The ratio of Mexicali emissions to Imperial County PM2.5 NA emissions ranges from 1.1 for ammonia to 13.7 for SOx (see Section VI). However, the ability to accurately evaluate and compare inventories is limited due to the lack of information for emission categories in the Mexicali inventory as well as the overall uncertainty for the emissions estimates provided.

III. Conceptual Model

A conceptual model, also known as a conceptual description, is a comprehensive summary of the state of the knowledge regarding the influence of emissions, meteorology, transport, and other relevant atmospheric processes on air quality in a

[4] Imperial County Comprehensive Economic Development Strategy: 2016 - 2017 Annual Update; published by the Imperial County Community & Economic Development Department.
[5] California Air Resources Board, Staff Report: Imperial County 2013 State Implementation Plan for the 2006 24-hour PM2.5 Moderate Nonattainment Area; December 8, 2014 release date.

given area. A conceptual model identifies the atmospheric processes and emission sources most responsible for the air quality issue under investigation and is useful in informing the development of effective strategies to reduce PM2.5 or other pollutants.[6] Because they are predicated on the best available information, conceptual models are updated and revised as new data and information become available.

The general steps that may be used to develop a conceptual model[7] are as follows; the last step involves aggregating information from the previous steps and developing key findings from the analyses.

- Introduce the general nature of the air quality problem to be addressed by the conceptual model;
- Describe the ambient monitoring network used for the conceptual model;
- Describe the status and trends of air quality in the area;
- Investigate possible relationships between emissions and air quality;
- Investigate possible relationships between meteorology and air quality; and
- Synthesize all of the relevant information into a detailed conceptual model.

The PM2.5 concentrations at the Calexico site represent emissions and air quality experienced in both Mexicali, Mexico and Imperial County. This technical demonstration for the Imperial County PM2.5 NA provides information addressing each of the steps above using an array of analytical tools, including source apportionment and photochemical modeling. The information from these and other included analyses support the postulate that cross-border emissions result in elevated PM2.5 concentrations on an annual basis and prevent Imperial County from attaining the annual PM2.5 standard. Where appropriate, the analyses also consider alternative explanations for the nonattainment status of the area.

The demonstration concludes with a synthesis of the analyses presented indicating that emissions originating from Mexicali impact the DV monitoring site, as well as other monitoring sites in the area, and that the area would attain the 12.0 µg/m^3 annual PM2.5 NAAQS in 2021 but for emissions from Mexicali.

IV. Imperial County Air Monitoring Network

Air quality monitoring serves a number of purposes. Under the Act, air quality monitoring is conducted to determine if the concentrations of pollutants, such as PM2.5, meet levels deemed to be protective of human health and welfare. In areas where the mechanisms generating air pollutant emissions are not well understood, air quality monitoring can facilitate the quantification and characterization of such emissions and help identify the contributing sources. Similarly, where emission sources can be readily identified, but where the relative impacts of individual sources on air quality are uncertain, air quality monitoring can be used to parse and rank such source

[6] U.S. EPA, “Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5 and Regional Haze,” December 2014, pages 9-11.
[7] *Ibid.*

contributions. Air monitoring networks designed to address each of these goals are found within the Imperial County PM2.5 NA.

The State or Local Air Monitoring Stations (SLAMS) make up the ambient air quality monitoring sites that are operated by State or local agencies for the primary purpose of comparison to the NAAQS. Within the Imperial County PM2.5 NA, the Imperial County Air Pollution Control District (District) operates PM2.5 monitors at stations in Brawley and El Centro, and the California Air Resources Board (CARB) operates a station in Calexico near the Mexico international border. A map of these monitoring stations is shown in Figure 4. Table 1 lists the PM2.5 samplers and related instrumentation used to collect data for this technical demonstration and operated during the baseline monitoring period of calendar years 2012 through 2014.

Data from the Calexico monitoring site include both mass measurements as well as chemically resolved (speciated) data. The speciated data is used to identify emission sources that may be contributing to an area's nonattainment status and provide information useful in developing an emission reduction strategy.

Figure 4. Imperial County PM2.5 Nonattainment Area and Monitoring Stations (2015)

Table 1. Imperial County PM2.5 NA Air Quality Monitors Operated in 2015

Station	2012 - 2015
Brawley	R&P 2025 FRM
El Centro	R&P 2025 FRM
Calexico	2 – R&P 2025 FRM 1 – Thermo 2025 FRM 2 – Thermo 2025i FRM 2 – Met One BAM 1020 FEM 2 – Speciation (SASS and URG)

Brawley and El Centro were deemed by the District to be reasonably homogenous urban sub-regions with similar land use patterns consisting of compact rural communities surrounded by agricultural lands. The proximity of Calexico to the international border and the metropolitan Mexicali area, however, led the District to deem monitoring sites in this community as representative of a populated area impacted by mobile source emissions and significant public exposure. Because $PM_{2.5}$ concentrations recorded in Calexico are the highest in the nonattainment area, CARB operated co-located Federal Reference Method (FRM) PM2.5 monitors at the Calexico site during the baseline period to determine annual trends, plus co-located continuous FEM monitors designed to provide the public with real time PM2.5 data supporting public health advisories.

V. Imperial County PM2.5 Air Quality

Data used for trend analyses and DV calculations rely exclusively on 2012-2015 FRM data collected at the Calexico monitoring site with a sampling schedule of 1-in-3 day in 2012 and 2013 and daily sampling starting on January 1, 2014. The air quality information below presents trends in DVs and annual averages, the frequency of observed concentrations, and trends in PM2.5 speciation data. The 3-year average of PM2.5 annual averages for each monitoring site, referred to as the DV, is used as the metric by which measured PM2.5 values are compared with the PM2.5 annual standard of 12.0 µg/m^3. More recent air quality data are analyzed in Appendix J.

A. Design Values

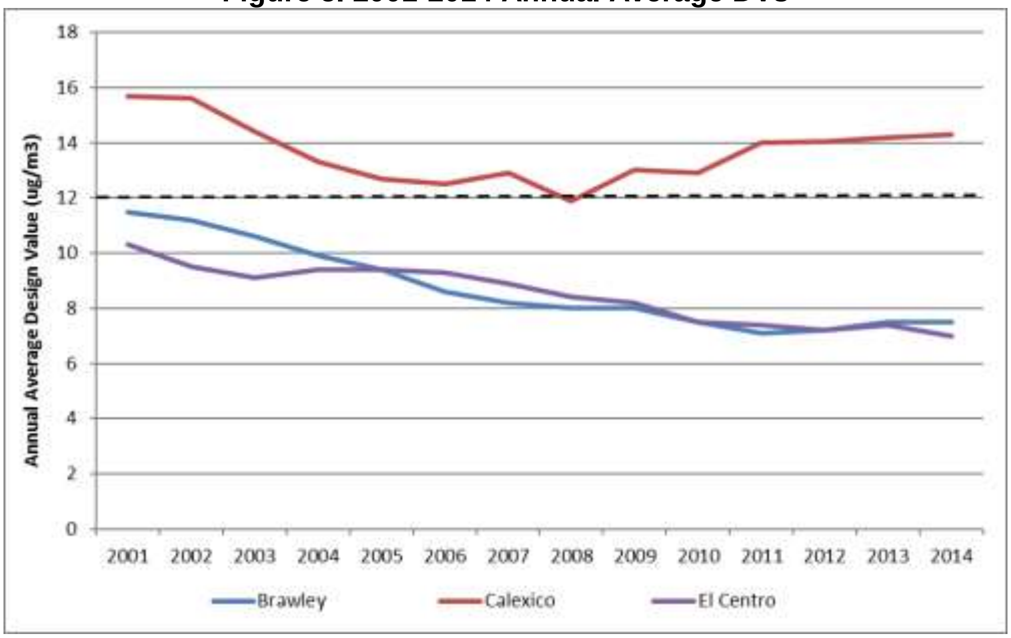
With the exception of the border area represented by the Calexico monitor, time series plots of air quality data in the Imperial County PM2.5 NA generally show improvement over the last 15 years. The trend in annual DVs for Calexico, El Centro, and Brawley illustrate the extent to which Brawley and El Centro annual average DVs track over time, while DVs for Calexico over the same period differ in both magnitude and direction (Figure 5).

Technical analyses conducted for the Imperial County SIP for the 24-hour PM2.5 standard, support the supposition that stagnant meteorological conditions impede dispersion and facilitate the build-up of PM2.5 concentrations in the Calexico-Mexicali air shed, particularly during the winter months of November through January.[8] These

[8] California Air Resources Board, Staff Report: Imperial County 2013 State Implementation Plan for the 2006 24-hour PM2.5 Moderate Nonattainment Area; December 8, 2014 release date.

meteorological conditions, coupled with emissions of local and international origin, impact the area's annual DV as well. In 2014, the Calexico annual PM2.5 DV was 14.3 µg/m^3, twice that seen at Brawley and El Centro (7.5 µg/m^3 and 7.0 µg/m^3, respectively). While Brawley and El Centro have responded similarly to California's emission control programs with a resulting improvement in air quality, Calexico's PM2.5 air quality remains above the standard.

Figure 5. 2001-2014 Annual Average DVs



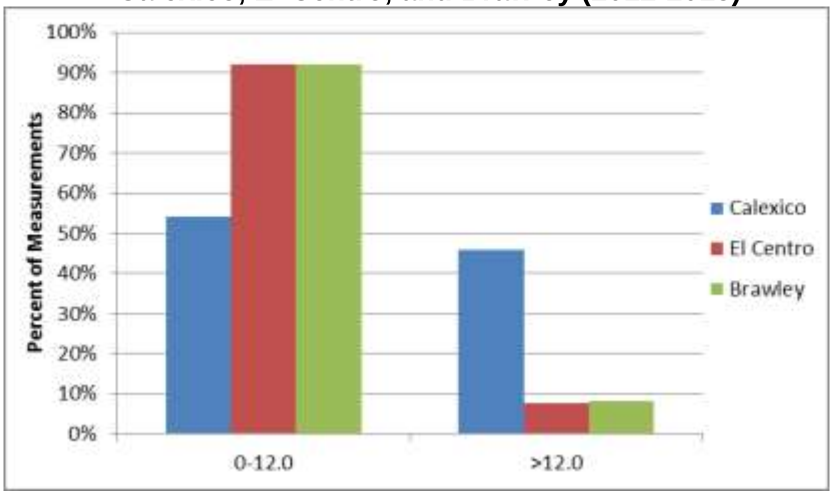
* PM2.5 monitoring began in Imperial County in 1999; 2001 reflects the 1999 - 2001 DV year.

B. Trends Analysis

To better assess PM2.5 air quality in the Imperial County PM2.5 NA over multiple years, daily PM2.5 concentration values recorded at Calexico, El Centro, and Brawley between 2012 and 2015 were analyzed in relation to the 12.0 µg/m^3 PM2.5 standard. The histogram in Figure 6 categorizes PM2.5 data measured at the three Imperial County PM2.5 NA sites between 2012 and 2015 into two bins with the upper end value of the first bin equal to the level of the annual PM2.5 standard. The data shows the percentage of measurements with concentrations within the annual PM2.5 standard range and above the annual standard. Between 2012 and 2015, almost half of the PM2.5 concentrations recorded at the Calexico monitoring site were over the annual standard of 12.0 µg/m^3, while less than 10 percent of the days at El Centro and Brawley experienced days over 12.0 µg/m^3.

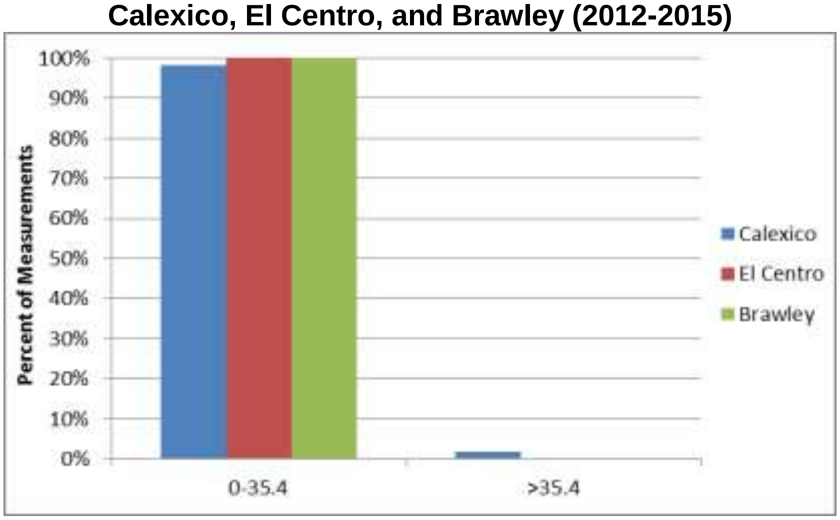
The data indicate that PM2.5 concentrations measured at Calexico are above the annual standard at a higher frequency than other PM2.5 sites in the Imperial County PM2.5 NA. The El Centro and Brawley sites show a similar pattern with the majority of samples collected reflecting measured PM2.5 values equal to or below the annual standard. While the cause for this difference is not evident from these data alone, the pattern suggests emission activities influencing Calexico are not regularly impacting monitoring sites farther to the north.

Figure 6. Percentage of PM2.5 Values Relative to the Annual Standard: Calexico, El Centro, and Brawley (2012-2015)



A similar plot of PM2.5 concentrations above the 35 µg/m^3 24-hour standard indicates that a greater number of values over the 24-hour standard occurred at the Calexico site than at either of the other sites (Figure 7). Because the annual standard is lower than the 24-hour standard, more values over 12.0 µg/m^3 recorded at each site are expected. The larger difference between the percentages of values above the annual standard recorded at Calexico and sites farther from the border versus those differences associated with the 24-hour standard suggests that Calexico is experiencing a year-round influence of cross-border emissions resulting in exceedances of the annual standard.

Figure 7. Percentage of PM2.5 Values Relative to the 24-Hour Standard: Calexico, El Centro, and Brawley (2012-2015)



To evaluate the temporal distribution of PM2.5 concentrations above the standard, data plots were constructed using the average monthly concentration measured at Calexico, El Centro, and Brawley from 2012 through 2015 (Figure 8). In addition, time series plots were developed using the coincident PM2.5 concentration data collected at Calexico, El Centro, and Brawley from 2012 through 2015 (Figure 9). For both data sets only PM2.5 FRM data were used for comparison purposes. Similar to the temporal pattern observed in the analysis conducted for the 24-hour plan[9], the majority of days with higher PM2.5 concentrations at Calexico occur during the winter months. Overall, measured PM2.5 concentrations at the Calexico site are higher than El Centro and Brawley on more than 97 percent of the days where data was recorded at all three sites.

Figure 8. Average PM2.5 FRM Concentration by Month from Monitoring Sites in Calexico, El Centro, and Brawley (2012 - 2015)

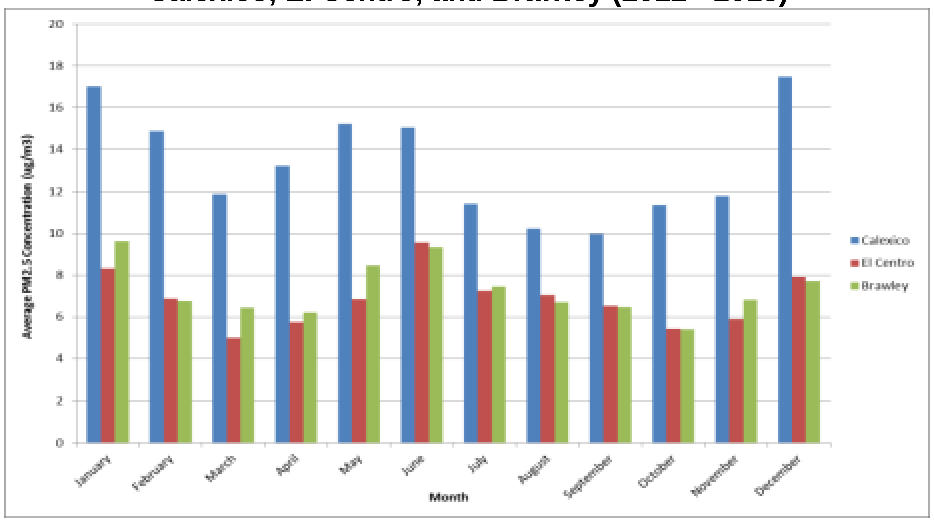
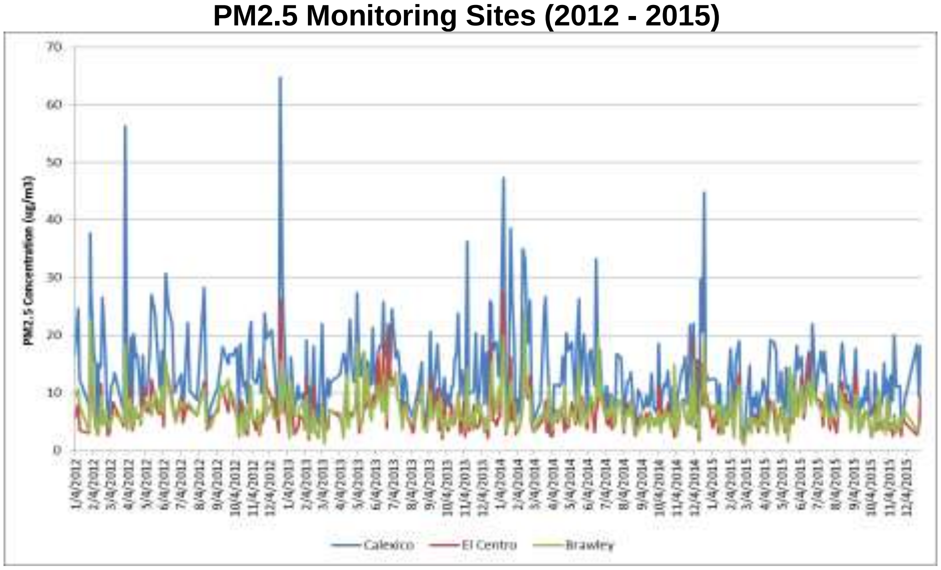


Figure 9. Coincident PM2.5 FRM Values at Imperial County PM2.5 Monitoring Sites (2012 - 2015)



[9] California Air Resources Board, Staff Report: Imperial County 2013 State Implementation Plan for the 2006 24-hour PM2.5 Moderate Nonattainment Area; December 8, 2014 release date.

While a similar pattern of elevated concentrations is noted during the winter months, as well as during the months of May and June, at each of the three sites, the magnitude of the concentrations are substantially higher at Calexico than at the more northern sites. From 2012-2015, the average monthly PM2.5 concentrations at Calexico are typically under 12.0 µg/m^3 during March and from July to November. By comparison, the average monthly PM2.5 concentrations at El Centro and Brawley are under 10 µg/m^3 throughout the year. For many months, Calexico is twice the level of Brawley and El Centro. The pattern in Figures 8 and 9 is consistent with the concept of cross-border emissions influencing concentrations in Calexico year around with peaks during the winter.

VI. Emission Inventory Comparison

The analyses presented in this discussion focus on identifying emission sources impacting the Calexico monitoring station and comports with the U.S. EPA guideline to compare emission inventories from each side of the border to assess the magnitude of the emission differences. PM2.5 samples collected in Calexico differ substantially in chemical composition from typical PM2.5 samples collected at other locations around the State and indicate Mexicali as the source of a large portion of the emissions impacting the Calexico monitor. For Mexicali, 2005 emission inventory data were derived from a report compiled by Eastern Research Group (ERG) in 2009.[10] Comparisons of PM2.5 and precursor emissions are reported below.

The 2005 Mexicali Emissions Inventory developed by ERG is the most recent, verifiable Mexicali inventory available. Since the Mexicali inventory was only available for 2005, the 2005 Imperial County PM2.5 NA emission inventory was backcast from the 2012 base year inventory developed for this annual PM2.5 SIP. A comparison of the two annual inventories in Tables 2 and 3 show the relative magnitude of the emissions in each jurisdiction by major source category. Emissions from sources in Mexicali are significantly higher than in the Imperial County PM2.5 NA for NOx, SOx, ROG, PM2.5, and ammonia. In both the Imperial County PM2.5 NA and Mexicali, more than 80 percent of the PM2.5 emissions are from area sources. In Mexicali, the majority of the PM2.5 emissions are from unpaved roads (62 percent) and agricultural burning (23 percent). In addition, agricultural burning in Mexicali is the largest source of NOx and SOx.

[10] Eastern Research Group, Inc. (ERG), "2005 Mexicali Emissions Inventory – Final Report" February 2009. Retrieved from: ftp://eos.arb.ca.gov/pub/projects/gei/USEPA-ERPcontract/Mexicali/2005 percent20Mexicali_EI_Draft percent20Final_10-03-08 percent20(2).pdf.

Table 2. 2005 Annual Imperial County PM2.5 NA Emission Inventory (tons/day)[11]

Source Category	NOx	SOx	ROG	PM2.5	Ammonia
Point Sources	2.5	0.1	1.1	0.9	1.3
Area wide Sources	0.2	0.0	6.0	11.7	22.4
On-Road Mobile	10.0	0.1	2.6	0.3	0.2
Other Mobile	11.0	0.9	4.8	1.2	0.0
TOTAL	**23.3***	**1.0**	**14.6**	**14.1**	**23.8**

Table 3. 2005 Annual Mexicali Emission Inventory (tons/day)[12]

Source Category	NOx	SOx	ROG	PM2.5	Ammonia
Point – Federal Sources	38.2	10.0	1.8	0.4	**
Point – State Sources	1.2	2.7	0.2	*	**
Area wide Sources	3.3	0.4	41.9	18.5	24.7
On-Road Mobile	23.5	0.5	24.6	1.8	0.7
Nonroad Mobile	12.3	0.2	1.5	1.5	**
TOTAL	**78.5**	**13.7**	**70.0**	**22.1**	**25.4**

** Total difference due to rounding.*
*** Emissions not estimated.*

In the Imperial County PM2.5 NA, 48 percent of the area wide PM2.5 emissions are due to unpaved roads and another 33 percent are due to fugitive windblown dust emissions, which include dust from agricultural lands, pasture lands, and unpaved roads and associated areas (canal roads). The ERG inventory for Mexicali did not account for fugitive windblown dust emissions so emissions estimates for PM2.5 would be higher if this category was included in the Mexicali emissions inventory.

In addition, PM2.5, ammonia, and methane emissions from 173 state jurisdiction point sources in Mexicali were not provided because emissions of these pollutants were not estimated by Baja California's Secretaria de Proteccion al Ambiente (SPA). The emission inventory for Mexicali also does not account for episodic emissions associated with cultural celebrations common in Mexico during the winter months. These celebrations are known to include extensive fireworks displays and the lighting of bonfires containing plastics, tires, and other materials. If all of these sources were incorporated into an annual emission inventory, the estimate of Mexicali emissions of PM2.5 and other pollutants would most likely increase substantially.

Combining emissions from the Imperial County PM2.5 NA and Mexicali together to form a single air shed inventory enables evaluation of the Imperial County PM2.5 NA contribution to the air shed. Based on the 2005 inventory values, NOx, SOx, ROG, PM2.5, and ammonia from the Imperial County PM2.5 NA contributed 23 percent, 7 percent, 17 percent, 39 percent, and 48 percent respectively, to the total air shed

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[11] California 2016 PM2.5 SIP Baseline Emission Projections - v1.05 Imperial PM2.5 Nonattainment Area.
[12] Eastern Research Group, Inc. (ERG), "2005 Mexicali Emissions Inventory – Final Report" February 2009. Retrieved from: ftp://eos.arb.ca.gov/pub/projects/gei/USEPA-ERPcontract/Mexicali/2005 percent20Mexicali_EI_Draft percent20Final_10-03-08 percent20(2).pdf.

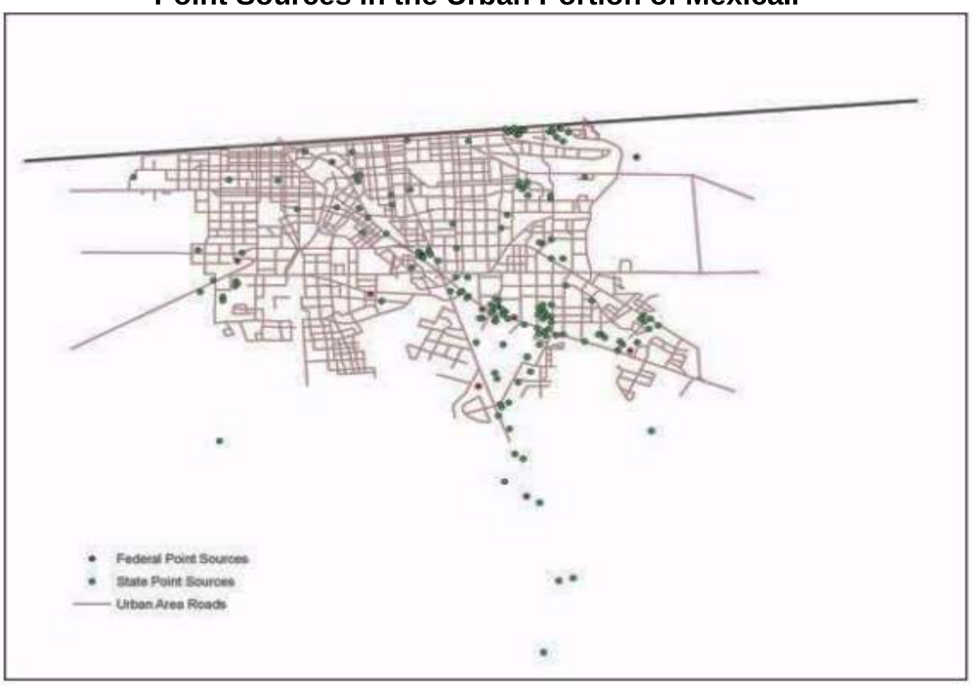
emissions. This approach provides a perspective on the relative contribution of local sources to the region's common air shed.

Several key point and mobile source categories in Mexicali were further examined in more detail. There are 16 federal-jurisdiction point sources in Mexicali which include: electrical generation, metal casting, paper production, glass manufacturing, iron and steel production, chemical/industrial gases, auto/truck manufacture, plastic parts manufacture, petroleum storage and distribution, and agricultural chemical facilities.

In addition, the 173 state-jurisdiction point sources in Mexicali include: mining, food, beverages/tobacco, wood products, paper production and publishing, petroleum and coal products manufacturing, chemical, plastics and rubber, nonmetallic materials manufacturing, primary metals and metal products, equipment and machinery manufacturing, computer/electronics manufacturing, electricity generation equipment manufacturing, transportation equipment, furniture manufacturing, and storage service.

The physical locations of some of the federal-jurisdiction and state-jurisdiction point sources in the urban portion of Mexicali are illustrated in Figure 10. Since emissions from the state-jurisdiction point sources were not estimated for PM2.5, it may be assumed that PM2.5 estimated from emissions would be much higher in Mexicali if these sources were included in the inventory.

Figure 10. Location of Federal- and State-Jurisdiction Point Sources in the Urban Portion of Mexicali[13]

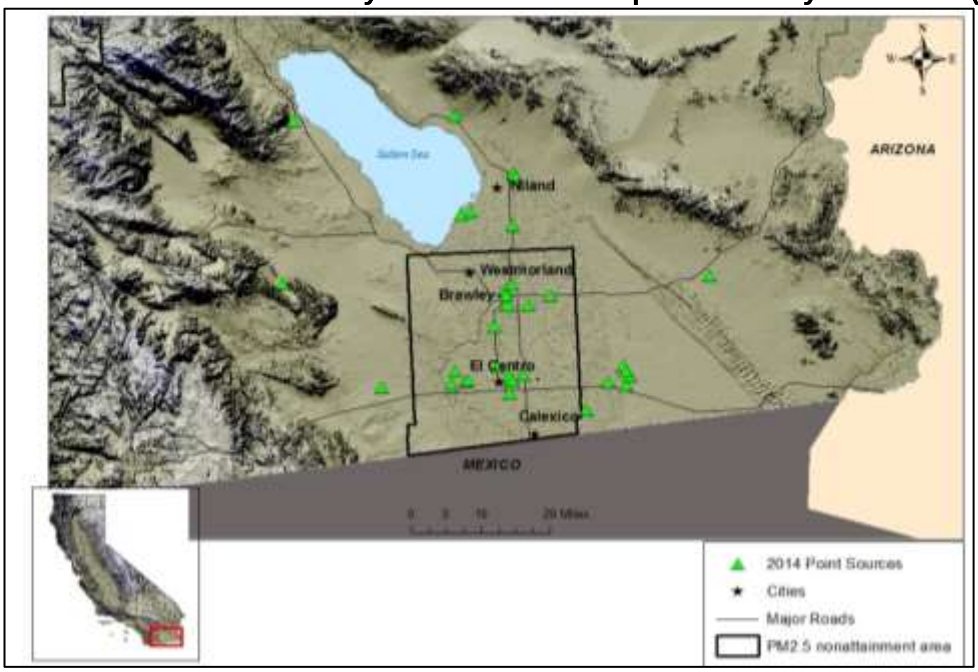


There are no major stationary sources of PM2.5 or any precursor emissions in the city of Calexico. The Imperial County PM2.5 NA contains stationary sources. It is important

[13] *Ibid.*

to note that although stationary sources are clustered around the cities of El Centro and Brawley, the PM2.5 concentrations at these sites are much lower than the PM2.5 concentrations at Calexico. Stationary or industrial sources are generally larger commercial or industrial facilities that are required to have a permit to operate issued by the District. The permitted facilities include factories, power plants, rock quarries, and other manufacturing and industrial facilities. The precursor pollutant for which the stationary source share of emissions is greatest is NOx (11 percent of the NOx emission inventory). Figure 11 below shows the location of the major stationary facilities in the Imperial County PM2.5 NA.

Figure 11. Location of Stationary Sources in the Imperial County PM2.5 NA (2014)



A comparison of the on-road mobile source emissions for each region was made and is shown in Table 4. The ratio of Imperial County PM2.5 NA to Mexicali on-road mobile source emissions shows that the Mexicali contribution exceeds the Imperial County by a factor of 2.4 to 9.5 on ton-per-day basis. This comparison illustrates the difference in magnitude of the emission inventories in the Imperial County PM2.5 NA and Mexicali, which as noted earlier, share a common air shed.

Table 4. 2005 Imperial County PM2.5 NA and Mexicali On-Road Mobile Source Emissions (tons/day)[14]

	Imperial County	Mexicali	Ratio
NOx	10	23.5	2.4
SOx	0.1	0.5	5.0
ROG	2.6	24.6	9.5
PM10	0.4	2.1	5.3
PM2.5	0.3	1.8	6.0

[14] *Ibid*.

It is known that the Mexicali inventory data are incomplete and uncertain; however, the magnitude of the difference between the two inventories suggests that Mexicali emissions are substantially higher than emissions from the Imperial County PM2.5 NA. Combined with the movement of emissions that typically occurs between two areas within a common air shed, this difference in emissions implies that the border region and the monitoring site in Calexico are heavily impacted by emissions transported across the border.

VII. Meteorology Impact

The majority of PM2.5 exceedances in Imperial County occur in Calexico where the impact of cross-border transport of emissions from Mexico is greatest. Monitors in Brawley and El Centro may also be impacted by emissions from Mexico, but their PM2.5 DVs are well below both the annual and 24-hour standards. The days with the highest PM2.5 concentrations in Calexico occur primarily during the winter months when stagnation conditions cause ambient concentrations from local emissions sources to accumulate. These exceedances share a pattern of low to calm wind speeds coupled with low ambient temperatures and mixing heights. However, PM2.5 concentrations above the level of the annual standard occur throughout the year at Calexico, El Centro, and Brawley, although they are much less frequent at El Centro and Brawley and the DVs at these sites are correspondingly well below the annual standard. The following analyses seek to evaluate the changes in PM2.5 concentrations with wind direction as mentioned in U.S. EPA guidelines.

A. Wind Direction

Monthly wind rose plots were made of the hourly average wind data in Calexico from 2012 through 2014 (Figure 12). The predominant wind patterns in the border region are from the northwest in the winter and southeast in the summer. Under stagnant conditions, pollutants within the Calexico-Mexicali air shed will tend to accumulate and exceedances will occur with greater frequency. As discussed later in this section the greatest number of low wind speed episodes occur October through February. As shown in Figure 12, calm wind (wind speed less than 1 m/s) occurs the most in January (20%) and the least in May (5%).

Figure 12. Calexico Wind Rose Plots (2012-2014)

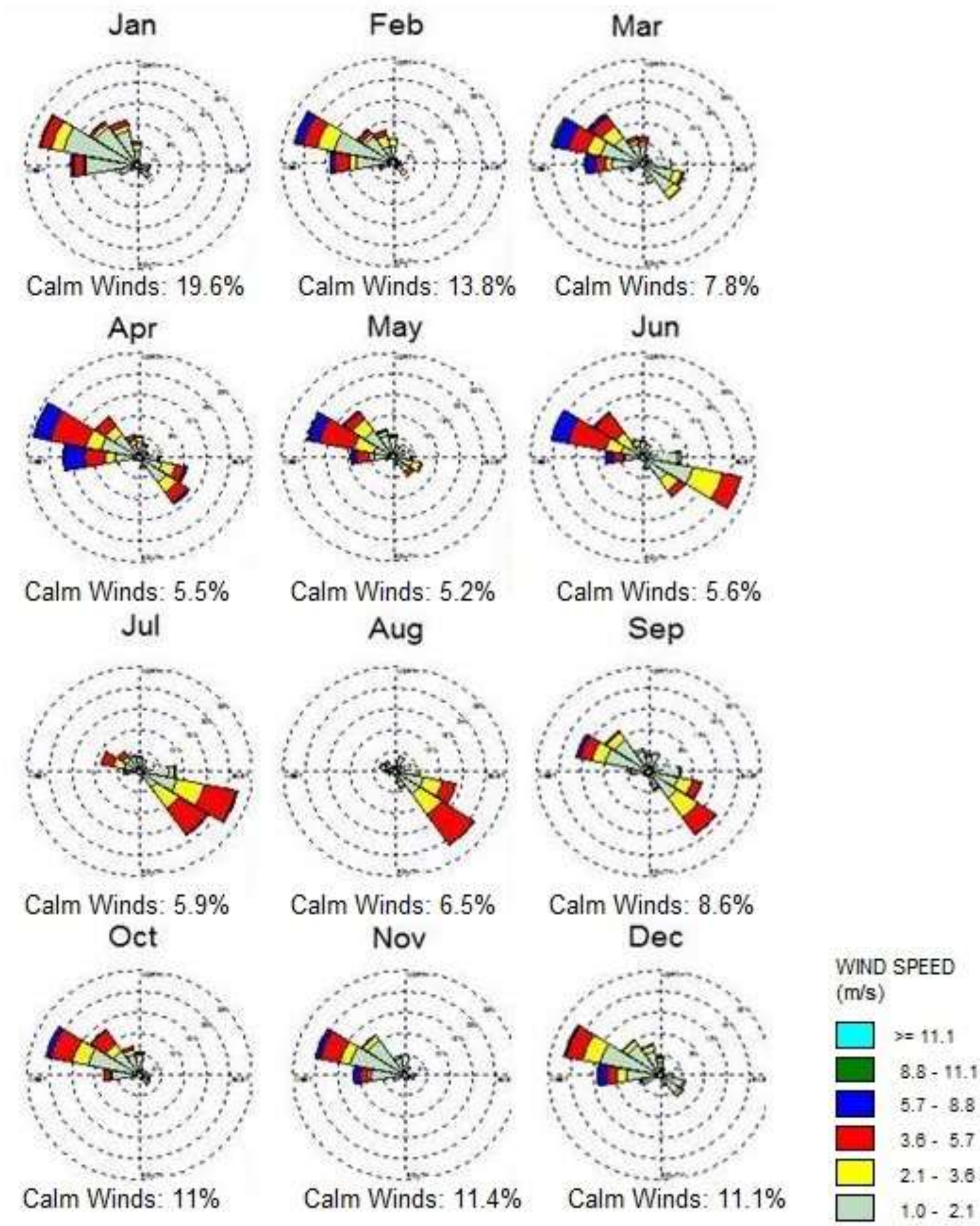
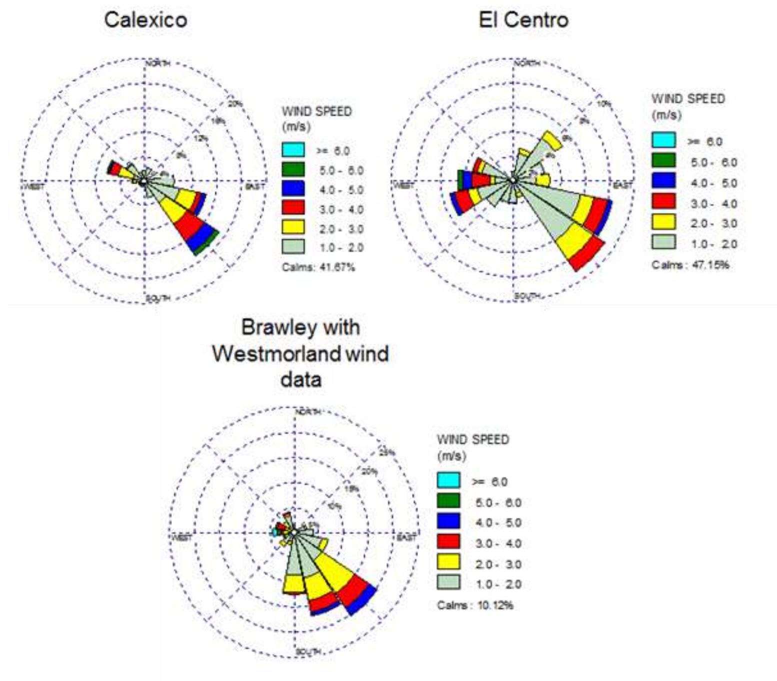


Figure 13 displays the wind roses for each of the three monitoring sites on days when all sites exceeded the level of the annual standard. These plots suggest that all of the PM2.5 sites in the Imperial County PM2.5 NA are impacted when the winds are generally from the southeast. The frequency of calm winds, indicative of stagnant conditions, occurs more at Calexico and El Centro than at the more northern Brawley site. Meteorological data is not available from the Brawley monitoring site so data from Westmorland were used as a proxy for wind speed and direction at the site.

Figure 13. Average Wind Rose on Days above 12 μg/m³ (2012-2014)



B. PM2.5 Impact by Wind Direction

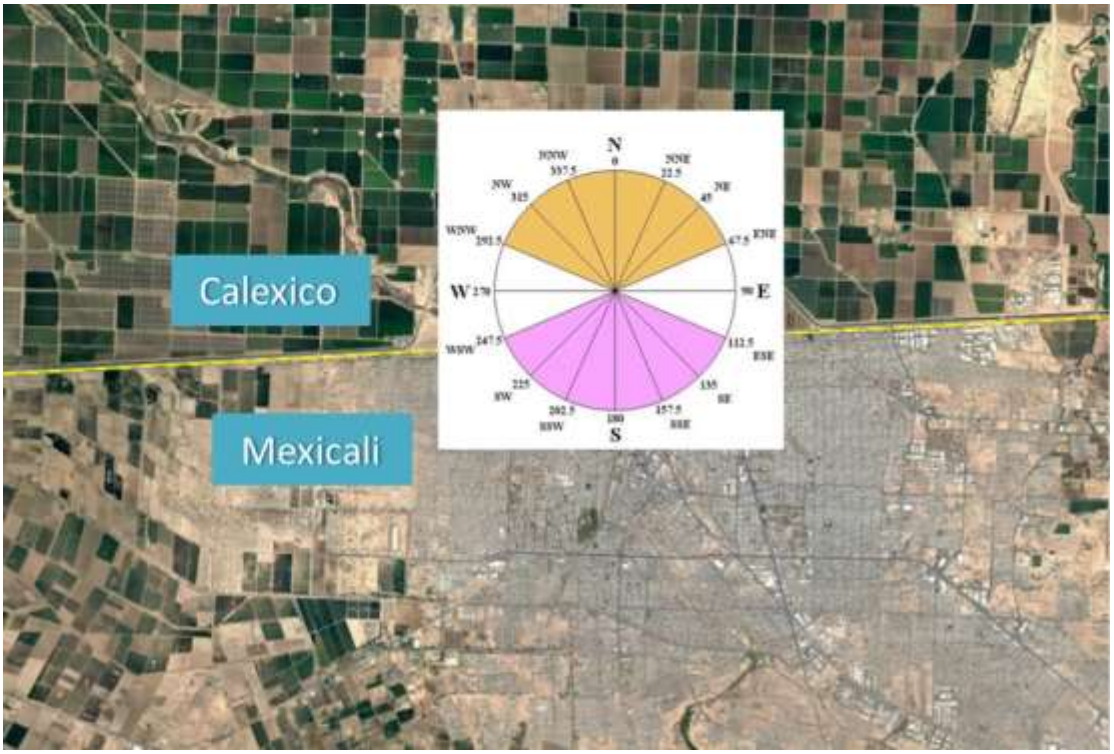
To assess the extent to which wind direction affected pollutant transport, hourly Beta-Attenuation Monitor (BAM)[15] PM2.5 measurements were binned by wind direction for all hours in 2012 through 2014. For this analysis, wind direction bins were established by dividing the compass into sixteen equal sized arcs, starting at due north. In order to look at the PM2.5 impact from each wind direction, hourly data must be used; therefore, hourly PM2.5 concentrations recorded by the primary BAM monitor at the Calexico station from 2012 through 2014 were assigned to a wind direction bin. Although BAMs generally record higher PM2.5 concentrations than the FRMs they provide useful information to evaluate the relative impact of emissions at the monitor. The averages of PM2.5 concentrations within each bin were then calculated and tabulated together with the number of hours of data in each bin.

The wind direction arcs are shaded to represent three separate upwind source areas (Figure 14). Segments ranging from 292.6 to 67.5 degrees, and crossing due north, designate winds blowing from the north (northern orange arc), transporting emissions only from Imperial County sources to the monitor. Segments ranging from 112.6 to 247.5 degrees include winds blowing from the south (southern pink arc), transporting emissions to the monitor from sources in Mexicali and in the narrow area of Calexico between the monitor and the border. Segments extending from 67.6 to 112.5 degrees and from 247.6 to 292.5 degrees bracket wind directions that transport mixtures of Calexico and Mexicali source contributions to the monitor. The data from these segments are not further evaluated in this analysis because of the uncertainty in origin

[15] PM2.5 BAM unit located at Calexico monitoring station (POC3).

of emissions transported from these directions. Assuming that winds from the northern arc transport emissions exclusively from sources within the Imperial County PM2.5 NA to the Calexico monitor, the relative impact of local sources on the monitor may be compared with PM2.5 concentrations from the other directions.

Figure 14. Compass Display of the Northern (orange) and Southern (pink) Wind Bin Arcs



PM2.5 average concentrations related to winds from the south were substantially higher than concentrations related to winds from the north (Table 5). Although winds occur more frequently from the north, the PM2.5 concentrations from within this sector range from an average of 10.2 to 15.3 µg/m^3, while concentrations within the southern sector range from an average of 18.5 to 26.1 µg/m^3.

To determine the impact of each wind segment on the 2014 DV at the Calexico monitor, an index was created by multiplying the average PM2.5 concentration by the number of wind hours in each segment in 2012-2014. This index provided a means to evaluate the “PM2.5 exposure” in µg/m^3 from each wind direction segment. The exposure index for each wind direction was then divided by the total index for all wind segments to obtain a “PM2.5 Exposure Fraction.” The last column in Table 5 shows the corresponding contribution in µg/m^3 to the DV of 14.3 µg/m^3 in 2014 for each wind direction bin.

Table 5. Calexico BAM Average PM2.5 DV Comparison by Wind Direction (WD) Bin

Degrees	Average BAM PM2.5 Concentration by WD	Count of Wind Hours in Segment	% of Hours from WD	PM2.5 Exposure Index (Column B x C)	PM2.5 Exposure Fraction (Index / Total)	Wind Segment Contribution to DV of 14.3
0-22.5	12.9	1079	4%	13924	4%	0.5
22.6-45	14.2	859	4%	12170	3%	0.5
45.1-67.5	15.3	886	4%	13596	4%	0.5
67.6-90	17.0	1297	5%	22003	6%	0.9
90.1-112.5	18.2	1979	8%	36020	10%	1.4
112.6-135	18.5	2789	11%	51559	14%	2.0
135.1-157.5	20.1	1347	5%	27054	7%	1.1
157.6-180	24.2	449	2%	10858	3%	0.4
180.1-202.5	26.1	303	1%	7908	2%	0.3
202.6-225	24.2	350	1%	8463	2%	0.3
225.1-247.5	20.0	459	2%	9191	3%	0.4
247.6-270	17.1	1260	5%	21505	6%	0.8
270.1-292.5	12.3	3497	14%	43012	12%	1.7
292.6-315	11.0	4117	17%	45387	12%	1.8
315.1-337.5	11.2	2059	8%	22998	6%	0.9
337.6-360	10.2	1764	7%	18018	5%	0.7
Total	272.4	24494	100%	363666	100%	14.3

This analysis shows that even though south winds occurred only 23 percent of the time in 2012-2014, their associated PM2.5 contribution to the Calexico DV was 4.5 µg/m^3. This strongly indicates that if southern winds and the corresponding Mexicali emissions were not impacting the Calexico monitor, the site would be in attainment of the annual 12.0 µg/m^3 PM2.5 standard.

Hourly PM2.5 concentrations recorded when winds were within each of the two wind direction arcs (north and south) were averaged to distinguish 3-year average concentrations when winds transported only Imperial County emissions to the Calexico monitor (north) versus when winds transported only Mexicali emissions to the monitor (south). The result, as presented in Table 6, indicates that the average PM2.5 concentration when winds are from Mexicali was almost double the average concentration associated with winds blowing from Imperial County source areas. The average PM2.5 concentration for the hours when the winds were from the north was 11.7 µg/m^3 in 2012-2014. In comparison, the corresponding average when winds were from the south was 20.2 µg/m^3, 73 percent higher.

Table 6. Hourly PM2.5 Average of all North and South Wind Hours at Calexico

Direction	Average PM2.5	Contribution to DV	% of time from WD
North (292.6-67.5)	11.7	4.9	44%
South (112.6-247.5)	20.2	4.5	23%

Table 7 below repeats the same analysis but using only PM2.5 concentrations recorded when wind speeds exceeded the transport threshold of 1.5 meters per second (m/s). Below this wind speed threshold, Calexico experienced stagnation conditions during which wind directions are variable and below measurement thresholds. The removal of these stagnation periods produces a more representative estimate of emission transport from sources upwind in either direction. The results, as shown in Table 7, exhibit a similar concentration gradient as seen in Table 5 above, with averages increasing as the direction shifts from north to south. Because episodes with very low wind speeds are characterized by higher PM2.5 concentrations, removal of these hours produces lower PM2.5 averages in all wind direction arcs.

Table 7. Calexico BAM Average PM2.5 DV Comparison by Wind Direction (WD) Bin (Winds Over 1.5 m/s)

Degrees	Average BAM PM2.5 Concentration by WD	Count of Wind Hours in Segment	% of Hours from WD	PM2.5 Exposure Index (Column B x C)	PM2.5 Exposure Fraction (Index / Total)	Wind Segment Contribution to DV of 14.3
0-22.5	8.2	360	3.0%	2950	2.2%	0.3
22.6-45	9.2	114	1.0%	1046	0.8%	0.1
45.1-67.5	10.7	32	0.3%	342	0.2%	0.0
67.6-90	12.9	120	1.0%	1552	1.1%	0.2
90.1-112.5	16.0	819	6.9%	13100	9.6%	1.4
112.6-135	16.4	1971	16.5%	32289	23.6%	3.4
135.1-157.5	17.1	788	6.6%	13487	9.8%	1.4
157.6-180	18.1	96	0.8%	1738	1.3%	0.2
180.1-202.5	16.4	39	0.3%	638	0.5%	0.1
202.6-225	15.3	42	0.4%	644	0.5%	0.1
225.1-247.5	13.7	64	0.5%	878	0.6%	0.1
247.6-270	10.7	450	3.8%	4798	3.5%	0.5
270.1-292.5	10.3	2250	18.9%	23167	16.9%	2.4
292.6-315	9.3	2852	23.9%	26450	19.3%	2.8
315.1-337.5	8.1	1050	8.8%	8518	6.2%	0.9
337.6-360	6.3	863	7.2%	5477	4.0%	0.6
Total	198.7	11910	100.0%	137074	100%	14.3

Table 8 shows that the average hourly PM2.5 concentration under northern non-stagnant wind conditions was 8.5 µg/m^3, with winds from these directions occurring 44 percent of the time. In comparison, the average hourly PM2.5 concentration under southern wind conditions was nearly double at 16.6 µg/m^3, with winds occuring only 25 percent of the time. This analysis further demonstrates that if Mexicali emissions were not impacting the Calexico monitor, even under non-stagnant wind speeds, the site would be in attainment of the annual 12.0 µg/m^3 PM2.5 standard.

Table 8. Hourly PM2.5 Average of all Non-Stagnant North and South Wind Hours at Calexico (Winds Over 1.5 m/s)

Direction	Average PM2.5	Contribution to DV	% of time from WD
North (292.6-67.5)	8.5	4.5	44%
South (112.6-247.5)	16.6	5.0	25%

Because the BAM FEM hourly concentrations are not those used in computing the PM2.5 DV for the Imperial County PM2.5 NA, the BAM data were converted into equivalent FRM DV contributions for comparison to the annual standard.
A BAM equivalent DV for the 2012-2014 baseline period was calculated from hourly BAM data using the same quarterly averaging and truncation protocols that are prescribed for computing a DV from 24-hour average FRM data. The intermediate and final values produced by this calculation are presented in Table 9 together with the corresponding values produced by computing the DV from FRM data. The relationship between FRM and BAM average concentrations varies from quarter to quarter in the

absence of any obvious trend, but the differences are small and the 3-year average DVs of 14.3 and 14.8 µg/m^3, respectively, differ by less than 4 percent.

Table 9. Calexico FRM and BAM 2012-2014 PM2.5 DVs

Monitoring Period		FRM	BAM
2012	Q1 Average	15.0	15.6
	Q2 Average	19.3	14.1
	Q3 Average	12.6	13.5
	Q4 Average	16.4	13.7
2013	Q1 Average	10.4	10.8
	Q2 Average	16.3	13.9
	Q3 Average	12.1	17.7
	Q4 Average	14.6	11.4
2014	Q1 Average	18.2	21.3
	Q2 Average	14.1	17.8
	Q3 Average	9.6	12.4
	Q4 Average	13.7	15.7
2012	4-Quarter Average	15.8	14.2
2013	4-Quarter Average	13.3	13.4
2014	4-Quarter Average	13.8	16.8
	3-Year Average DV	14.3	14.8

The ratio of FRM to BAM DVs (0.966) was applied to the wind direction arc BAM average PM2.5 concentrations in Table 9 to derive equivalent FRM PM2.5 average concentrations for the same wind direction arcs. The results of this conversion are shown in Table 10.

The equivalent FRM PM2.5 average concentrations show that winds approaching the Calexico monitor from the north are characterized by substantially cleaner air quality than winds from the south. When the FRM-equivalent PM2.5 concentrations from all hours in 2012-2014 with north winds are averaged together, the result, 11.3 µg/m^3, is below the level of the annual PM2.5 standard. By comparison, the corresponding average with winds from the south is 19.5 µg/m^3, a level 63 percent higher than the annual standard.

Table 10. Calexico 2012-2014 PM2.5 Equivalent FRM Average Concentrations by Wind Direction Arc

Wind Direction Arc (degrees)	Average BAM PM2.5 by Wind Direction Arc	Average Equivalent FRM PM2.5 by Wind Direction Arc
0-22.5	12.9	12.5
22.6-45	14.2	13.7
45.1-67.5	15.3	14.8
67.6-90	17.0	16.4
90.1-112.5	18.2	17.6
112.6-135	18.5	17.9
135.1-157.5	20.1	19.4
157.6-180	24.2	23.4
180.1-202.5	26.1	25.2
202.6-225	24.2	23.4
225.1-247.5	20.0	19.3
247.6-270	17.1	16.5
270.1-292.5	12.3	11.9
292.6-315	11.0	10.6
315.1-337.5	11.2	10.8
337.6-360	10.2	9.8
Average All WD (2012-14)	14.8	14.3
Wind Direction Arc (degrees)	**Average BAM PM2.5 by Wind Direction**	**Average FRM PM2.5 by Wind Direction**
North (292.6-67.5)	11.7	11.3
South (112.6-247.5)	20.2	19.5

C. Wind Speed

It is clear that wind direction has a great impact on PM2.5 concentrations at the Calexico site. However, wind speed is another important factor to consider when assessing the PM2.5 concentrations experienced at the Calexico site. The relationship between wind speed and BAM PM2.5 concentrations was evaluated by plotting the daily average BAM measurements with the daily average resultant wind speed data at the Calexico monitor. Figure 15 illustrates a reverse correlation, indicating PM2.5 concentrations increase as wind speed decreases.

Figure 15. Calexico 24-Hour Average PM2.5 Concentrations and Wind Speed

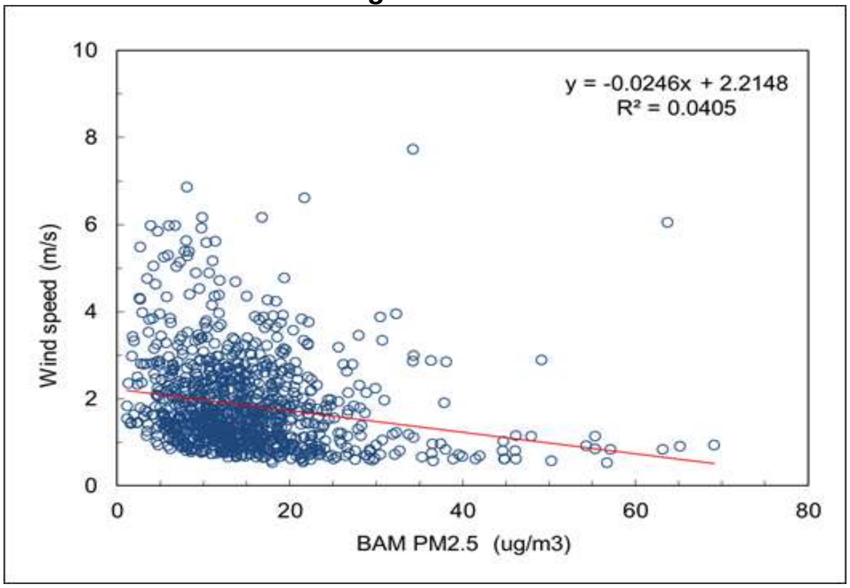
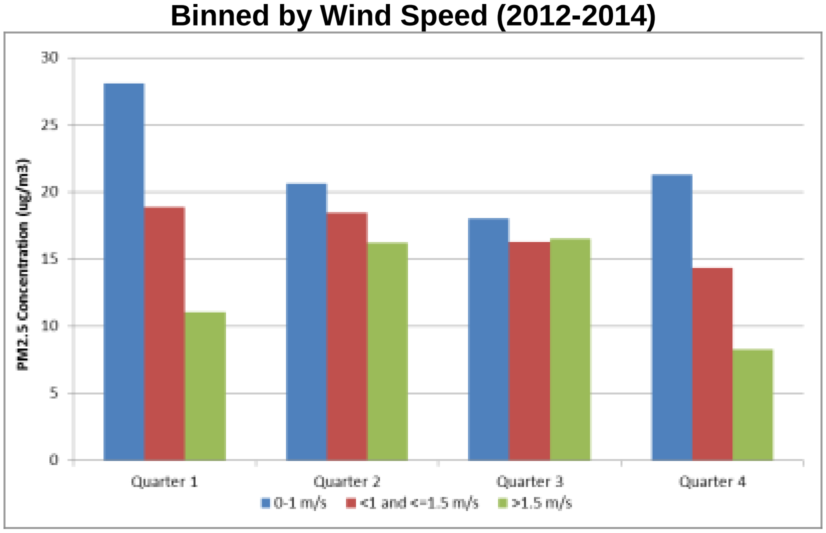


Figure 16 shows the average hourly PM2.5 concentration at Calexico for each quarter from 2012 through 2014, based on binned wind speed. PM2.5 concentrations are highest under stagnant conditions and during the first and fourth quarters of the year. During these quarters, there are periods of increased concentrations at the Calexico monitor due to pollutants accumulating under stagnant meteorological conditions; when higher wind speeds occur, they help to disperse pollutant buildup, resulting in a subsequent concentration decrease. For all four quarters, the highest PM2.5 concentrations occur under very low wind speed conditions.

Figure 16. Calexico Average Hourly PM2.5 Concentrations for Each Calendar Quarter Binned by Wind Speed (2012-2014)

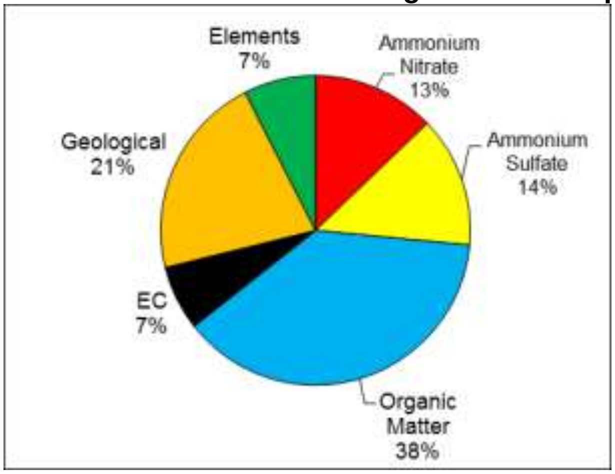


VIII. Analysis of Calexico Filters

Of the three PM2.5 monitoring sites in the Imperial County PM2.5 NA, the Calexico site is the only current monitoring location with instrumentation capable of collecting samples for chemical speciation. Calexico speciation data were evaluated for the presence of specific elements that would assist in identifying particular emission sources. Based on available data from 2010 through 2012, compositional analysis shows that PM2.5 at Calexico is primarily organic matter followed by geological material. The analysis was limited to the use of PM2.5 speciation data from 2010 through 2012 due to the invalidation of more recent data. See Appendix C for the data screening technique used to identify invalid data.

Figure 17 shows the average PM2.5 composition at Calexico from 2010 through 2012. This data was scaled to the 2012, 2013, and 2014 DV average due to the invalidation of speciation data in 2013 and 2014. Sample analysis indicates that the particulate matter is comprised primarily of carbonaceous aerosols (organic matter (OM) plus elemental carbon (EC)), which make up about 45 percent of the PM2.5 mass on average between 2010 and 2012. Carbonaceous aerosols peak in the wintertime, but remain relatively constant throughout the remainder of the year (Figure 18). The observed pattern in total chemical composition is similar to the pattern in average mass in Figure 17. Much of the carbonaceous aerosol particles originate from combustion sources (burning, tailpipe emissions, etc.).

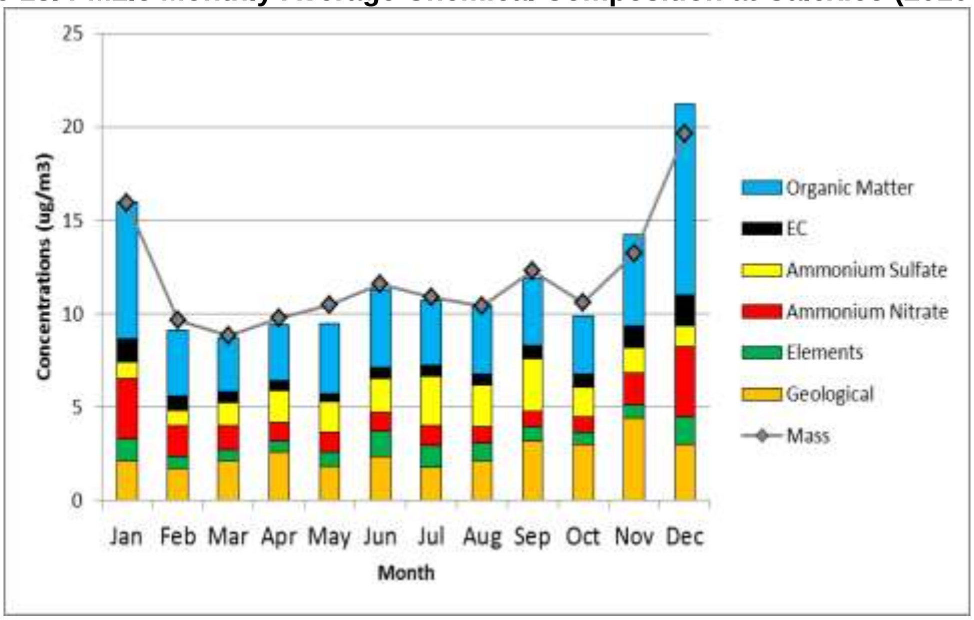
Figure 17. Calexico 2010-2012 Average PM2.5 Composition



Ammonium nitrate and ammonium sulfate also contribute a substantial portion of the measured PM2.5 at Calexico. Ammonium nitrate in particular is formed from the reaction of ammonia and nitric acid. This reaction is higher in the wintertime due to cooler temperatures and higher humidity, which are conducive to a series of complex reactions involving NOx, ammonia, and ROG. Ammonium sulfate is highest during the summer months and is the product of a reaction involving ammonia and sulfuric acid.

Figure 18 illustrates the seasonal pattern in PM2.5 mass and its components at the Calexico site with the highest concentrations occurring during the winter months, mainly due to increases in organic matter, elemental carbon, and ammonium nitrate. Geological dust is the second highest contributor to PM2.5 at Calexico and is largely due to the surrounding large expanses of desert and arid regions in the air shed. The geological component remains fairly constant throughout the months, with slight increases in the fall and early winter months.

Figure 18. PM2.5 Monthly Average Chemical Composition at Calexico (2010-2012)



Filter Analysis for Elements

As mentioned earlier, Calexico is the only monitoring site in Imperial County currently collecting chemical speciation data. To quantify the elemental species concentrations and compare among the three Imperial County sites, X-ray fluorescence (XRF) analysis was performed on 17 filters from each of the primary FRM samplers at the Calexico, El Centro, and Brawley sites for a total of 51 samples analyzed.

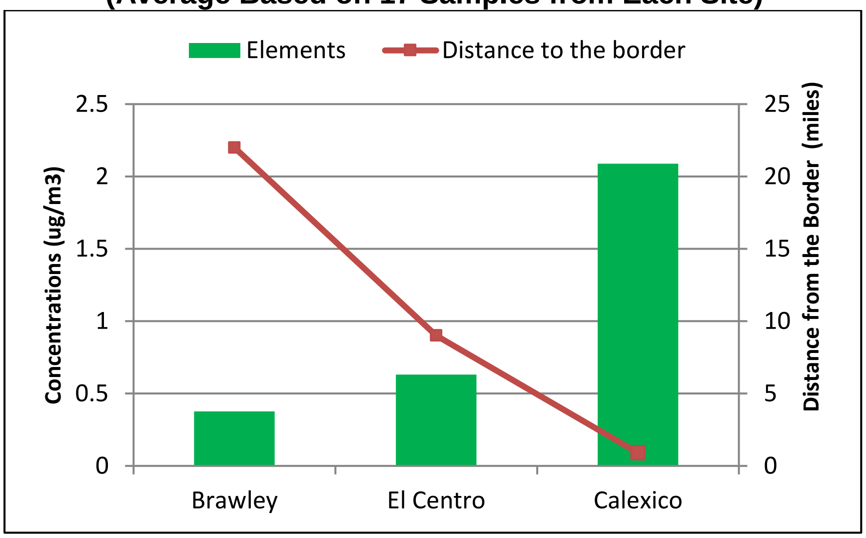
The objective was to compare the elemental species concentrations at the Imperial County PM2.5 NA sites given that elements are particularly useful tracers in identifying sources of emissions. For example, non-geologic elements are tracers of industrial source activities, high-polluting vehicles, and refuse combustion. The filters selected for analysis were chosen to include all seasons and represent a wide range of concentrations, from about 9 µg/m^3 to almost 65 µg/m^3. Appendix A includes additional details as to the analysis method, the screening of samples, and results.

Results indicate that elemental species concentrations increased with proximity to the border. The lowest values were observed at Brawley, about 22 miles north of the border, where the average concentration of non-geologic elements was 0.37 µg/m^3. Concentrations were twice as high at El Centro, about 9 miles north of the border, with an average of 0.63 µg/m^3. The non-geologic element concentrations reached a maximum at Calexico where the average sum of non-geologic elements was 2.09 µg/m^3.

Figure 19 compares the concentrations of non-geologic elemental species at the three sites. As noted, the levels observed at Calexico were substantially higher, indicating that activities unique to this location make a significant contribution to PM2.5 levels. Non-geologic elemental species concentrations at the Calexico site were four and six times higher than El Centro and Brawley, respectively. The most abundant non-geologic elements in Calexico samples were chlorine, potassium, and iron with average concentrations of 1.2 µg/m^3, 0.5 µg/m^3, and 0.3 µg/m^3, respectively. Concentrations of these species were up to 12 times higher than at the other two Imperial County sites.

Activities known to occur in the Mexicali area, including a substantial number of manufacturing and assembly plants (*maquiladoras*), small-scale brickyards, and uncontrolled combustion of refuse and other materials, suggest that unusually high measurements of PM2.5 elements in Calexico are likely due to transport from Mexicali.

Figure 19. Concentrations of Non-Geological Elemental Species (Average Based on 17 Samples from Each Site)



To assess the relationship between the total mass and the concentration of total non-geologic elemental species, the data were separated into three concentration bins (Figure 20). Higher PM2.5 concentrations contained substantially more non-geologic elemental species. This may mean that the emission sources driving the higher concentration levels recorded in Calexico, but not in El Centro or Brawley, are also the source of non-geological elemental species. The increase of non-geological elemental species concentrations seen at El Centro and Brawley is consistent with observations at other sites in California (Figure 21).

Figure 20. Binned Concentrations of Non-Geologic Elemental Species Based on 17 Samples for Each Site

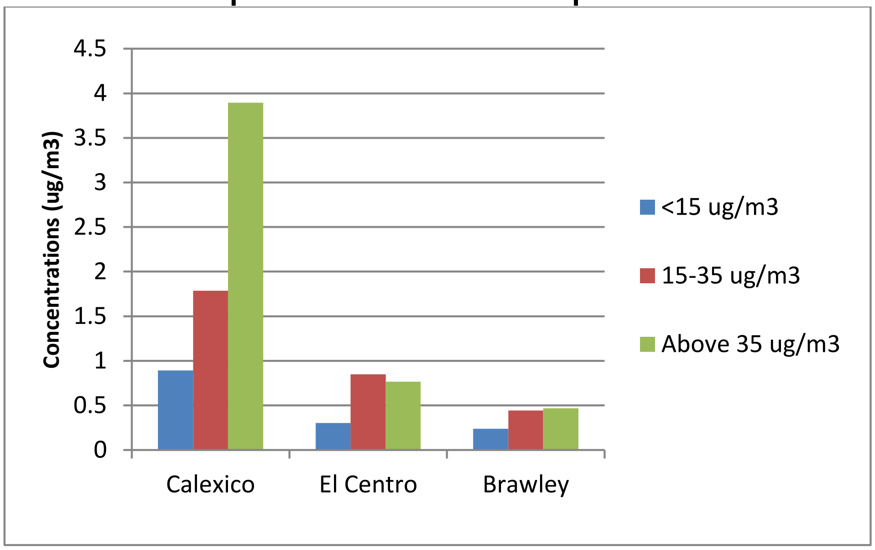
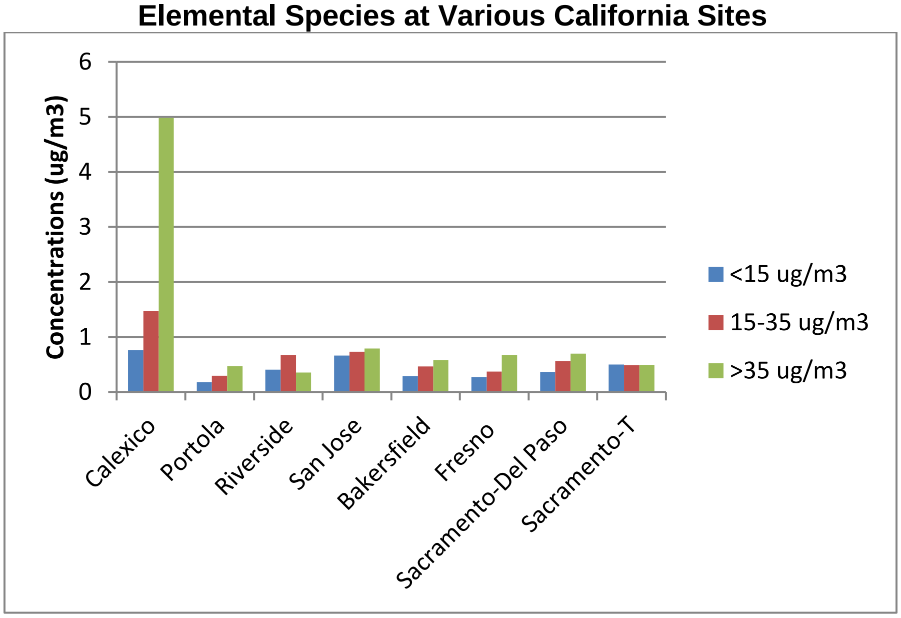
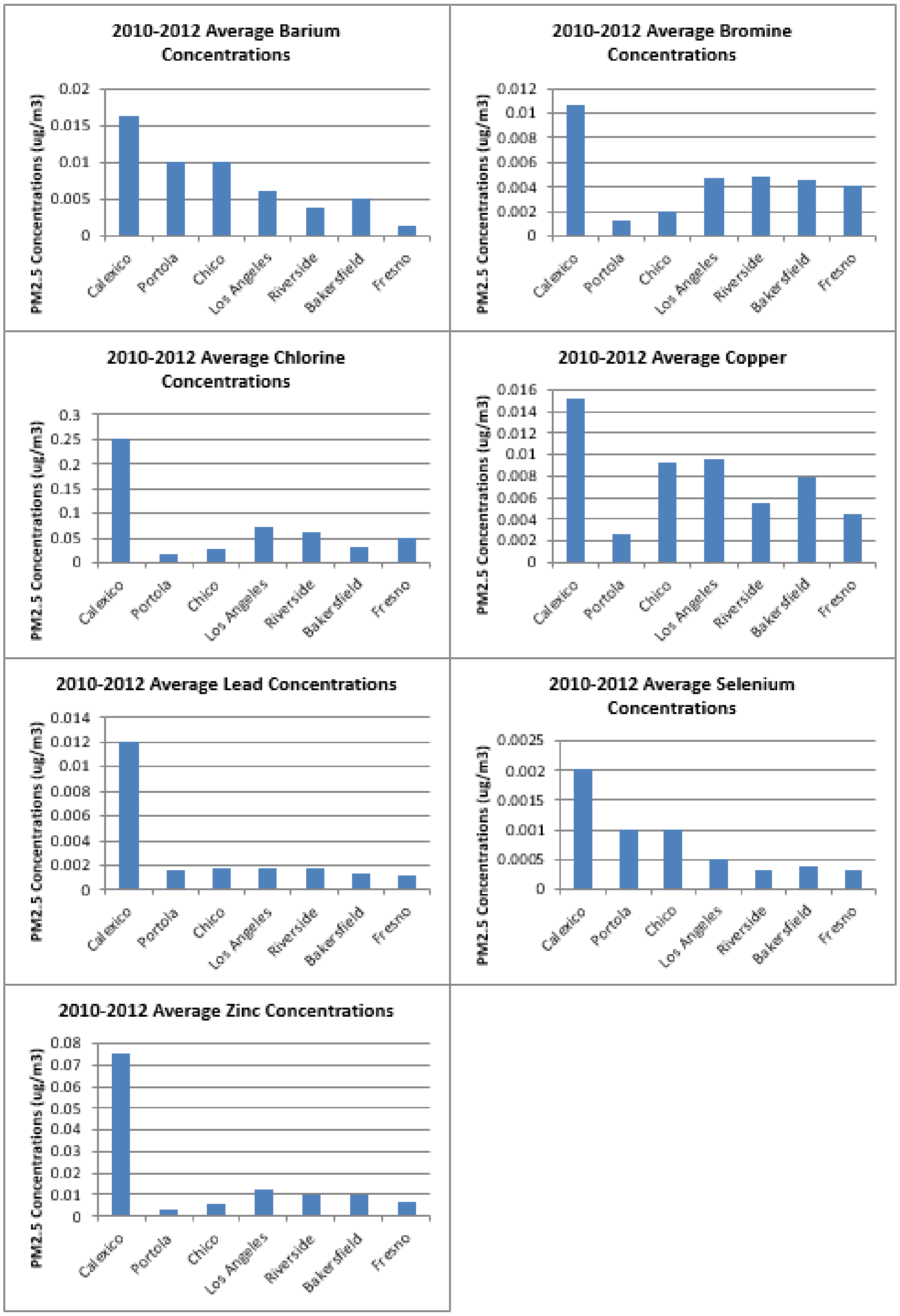


Figure 21. Concentrations of Non-Geologic Elemental Species at Various California Sites



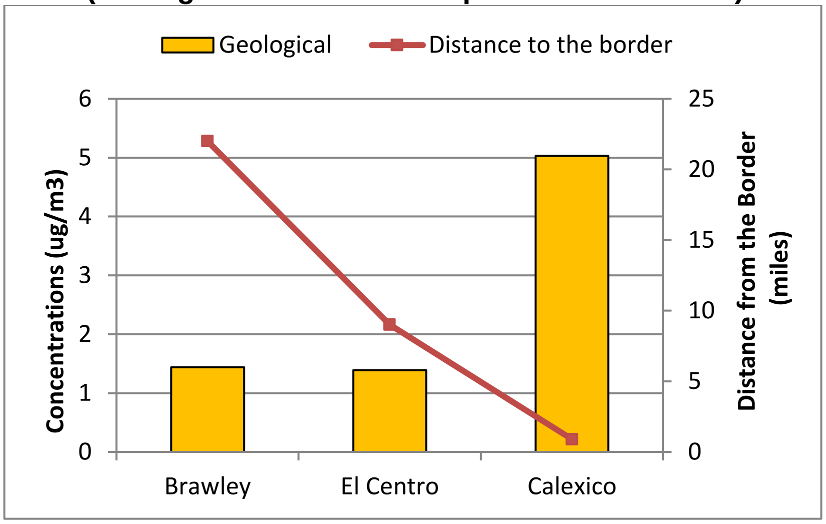
Staff compared Calexico speciation data to other locations in the State and noted both similarities and differences in the profiles. Figure 22 compares barium, bromine, chlorine, copper, lead, selenium, and zinc to other sites in California. These elemental components measured two to twenty-two times higher than at other sites in California. Concentrations of these elements are low throughout California due to strict environmental controls on industry, the transportation sector, and waste disposal.

Figure 22. 2010-2012 Average Concentrations of Select Elemental Species



Concentrations of geological material were also highest at Calexico (Figure 23). Geological material from PM2.5 filters collected from Brawley and El Centro were about 70 percent lower than Calexico. The elevated concentrations of geological material may be due to emissions from unpaved roads and agriculture in Mexicali, a significant and continuing source of PM in the region. Imperial County has best available control measures in place to control dust emissions from unpaved roads and agriculture.

Figure 23. Concentrations of Geological Species (Average Based on 17 Samples from Each Site)



IX. Analysis of Imperial County Emissions Inventory

Because of the similarities in emission source patterns in areas surrounding the Calexico (U.S. portion), El Centro, and Brawley monitoring stations, and the dissimilarities in PM2.5 annual average concentrations recorded at the Calexico station compared with those at the El Centro and Brawley stations, an analysis of the relationships between PM2.5 emission inventories and air quality in these three communities was conducted. The objective was to estimate the annual average PM2.5 concentration that would exist at the Calexico station if the emission source patterns surrounding the station were the same as those to the north of the international border in the absence of Mexicali emissions sources. Figure 4 (p. 7) displays a satellite image showing the PM2.5 nonattainment area with the locations of the three PM2.5 monitoring stations. This analysis is intended to respond to U.S. EPA guideline recommendations for areas to analyze emission inventories on the U.S. side of the border and demonstrate that the impacts of U.S. sources do not cause NAAQS exceedances.

A gridded emissions inventory for the nonattainment area was available for the year 2012. The gridded emissions inventory for 2012 was used in this analysis since more recent data did not exist. Examination of simultaneous PM2.5 measurements recorded during 2012 at the three PM2.5 monitoring stations within the Imperial County PM2.5 NA consistently show substantially higher values at the Calexico station. This analysis explores whether there are differences in near-monitor emissions inventories that can explain the differences between annual average PM2.5 concentrations at Calexico as compared to Brawley and El Centro.

The similarities in the annual average PM2.5 values recorded at El Centro and Brawley suggest similarities in the emissions strengths of sources impacting each monitor, given that meteorological conditions at these two stations spaced 13 miles apart are relatively similar. Both communities share similar economies, primarily retail and service centers for a surrounding area devoted exclusively to agricultural production. Both cities have moderately small populations, 45,170 in El Centro and 26,566 in Brawley.[16] The two communities also share the same emission sector characteristics: rural light- and heavy-duty vehicle traffic volumes, limited industrial emissions, and extensive agricultural cultivation activities on the lands surrounding each community.

Contrasting the emission source patterns of El Centro and Brawley to that of Calexico revealed unexpected similarities. When viewed from the international border looking north, Calexico shares the same emission source characteristics as El Centro and Brawley: generally rural vehicle traffic volumes (with the exception of cross-border traffic), limited industrial emissions, and extensive agricultural cultivation activities on the surrounding lands lying within the U.S. Given the similar populations and source types, the emission inventories of Calexico, El Centro, and Brawley should be somewhat similar, and because the annual meteorological conditions at each of the three cities are very similar, the annual PM2.5 concentration averages in the three cities should also be fairly similar.

Emission inventories were prepared for the Imperial County area to satisfy a number of SIP regulatory requirements. The most detailed emission inventory specific to the PM2.5 nonattainment area was prepared on a spatially gridded basis for air quality modeling using photochemical models. This gridded inventory contains calendar year 2012 hourly emission rates for each of the directly emitted PM2.5 species. These hourly emission rates were summed spatially over modeling grid cells measuring 4 kilometers (km) by 4 km. Because of this level of detail, the SIP modeling emission inventory was used in this analysis.

The spatial boundaries encompassing the largest numbers of emissions sources impacting each of the three monitoring stations was the first task in assembling community-specific inventories. The grid cell boundaries overlaid on a satellite image of the three communities is shown in Figure 24. The initial review of the map in Figure 24 revealed that the urbanized portions of each of the three communities being studied lay almost entirely within single modeling grid cells. Additionally, when the rings of immediately-adjacent grid cells were added to the urbanized community cells to create community-specific emission inventory domains, the resulting three domains, shown in red outline, were found to be equal-sized and non-overlapping, with the urbanized centers located generally in the center grid cells of the subsequent 12 km by 12 km inventory domains. This configuration of inventory domains was deemed to be appropriate for minimizing bias in the comparison of emission inventories responsible for the majority of directly emitted PM2.5 impacts at each of the three monitoring stations.

[16] California Department of Finance Demographic Research Unit; Report E-1, Population Estimates for Cities, Counties, and the State; January 1, 2015 and 2016; http://www.dof.ca.gov/Forecasting/Demographics/Estimates/E-1/.

Since the international border lies only 0.7 miles south of the Calexico monitoring station, the 12 km by 12 km inventory domain for the Calexico station extends south of the border into Mexico. In Figure 24, the international border can be seen near the bottom of the image. The three southern-most modeling grid cells in the Calexico inventory domain lie entirely within the Mexicali metropolitan area. When excluding these three cells from the domain, the emission source pattern in the remaining six grid cells looks very similar in source distribution to those surrounding the El Centro and Brawley stations.

A small sliver of Mexican territory lies within the three grid cells lying along the line east and west of the Calexico station, occupying approximately 18 percent of the land area of these three grid cells combined.

Figure 24. Imperial County PM2.5 Nonattainment Area Modeling Grid Cell Boundaries

To assure that emissions from sources within this sliver are excluded from the Calexico inventory domain, the emissions from Mexican sources that were originally allocated to each of these grid cells was subtracted from the 2012 baseline inventories to reduce cell emissions to only those produced by sources on the U.S. side of the border.

The 2012 Calexico annual average PM2.5 concentration due only to impacts from emissions sources in the U.S. was calculated by assuming that the relationship between domain-wide PM2.5 direct emissions and annual average PM2.5 ambient concentrations was the same in each of the three nonattainment area communities with monitoring stations. The details of these calculations are provided in Appendix B. The 2012 annual average monitored PM2.5 concentrations, the 2012 directly-emitted PM2.5 emission densities calculated in Appendix B, and the ratios of these values for each of the three nonattainment area communities are shown in Table 11.

Table 11. Community 2012 PM2.5 Emission Densities and Annual Average Concentrations

Monitoring Station	Emission Density ($kg/hr\text{-}km^2$)	Annual Average PM2.5 ($\mu g/m^3$)	Ratio of Annual Avg. PM2.5 to Emission Density ($\mu g/m^3$ / $kg/hr\text{-}km^2$)
Brawley	0.76	8.1	10.7
El Centro	0.65	7.5	11.5
Calexico	0.65	15.8	24.5

Because the relationship between direct PM2.5 emissions and air quality at the Calexico station is substantially different from those at Brawley and El Centro, and because the meteorology at Calexico is very similar to that of the other two communities, the higher annual average PM2.5 level recorded at Calexico is most likely due to impacts from Mexicali emissions sources. The annual average PM2.5 level in Calexico due exclusively to emissions from sources within Imperial County was estimated by applying an average of the air quality-to-emissions ratios calculated for the other two communities to the emission density value derived for the Calexico area. These calculations and the resulting annual average PM2.5 concentration in 2012 for Calexico are shown in Table 12.

Table 12. Calexico 2012 PM2.5 Annual Average Estimate

Monitoring Station	Emission Density ($kg/hr\text{-}km^2$)	Annual Average PM2.5 ($\mu g/m^3$)	Ratio of Annual Avg. PM2.5 to Emission Density ($\mu g/m^3$ / $kg/hr\text{-}km^2$)
Brawley	0.76	8.1	10.7
El Centro	0.65	7.5	11.5
Calexico	0.65	7.2	11.1 (averaged)

Using this technique shows that the 2012 annual average PM2.5 concentration in Calexico would have been 7.2 $\mu g/m^3$ instead of 15.8 $\mu g/m^3$. This analysis provides additional evidence that in the absence of impacts from Mexicali emissions sources, Imperial County would attain the annual PM2.5 NAAQS.

X. Source Apportionment and Directional Analysis

To further identify potential PM2.5 sources affecting the Calexico monitor, the following technique was applied which relied on air quality, emissions, and meteorological data using established techniques. PM2.5 speciation and meteorological data collected at the Calexico site were analyzed using a source apportionment method known a Positive Matrix Factorization (PMF). This method comports with U.S. EPA guidelines to analyze filters for specific particles that may be tied to foreign emission sources and to perform receptor modeling (source apportionment) to quantify the impacts from U.S. and foreign emission sources

Source apportionment analysis at the Calexico site utilized PM2.5 speciation and meteorological data. Speciation data collected between January 2013 and August 2014 were determined to be invalid and not included in this analysis because of concerns regarding the sampler flow rate (see Appendix C). Instead, PM2.5 speciation data collected in 2011 and between September 2014 and August 2015 were included in a manner that equally weighted data by month and season.

As shown in Figure 25, PMF identified seven major sources of PM2.5 in Calexico based on an analysis of 148 data points collected between January 2011 and August 2015: airborne soil, biomass burning, mobile, secondary sulfate, secondary nitrate, refuse burning, and industrial sources. Average source contributions applied to the 2014 PM2.5 annual DV are presented in Table 13.

Figure 25. Average Source Contributions in Calexico (2011-2015)

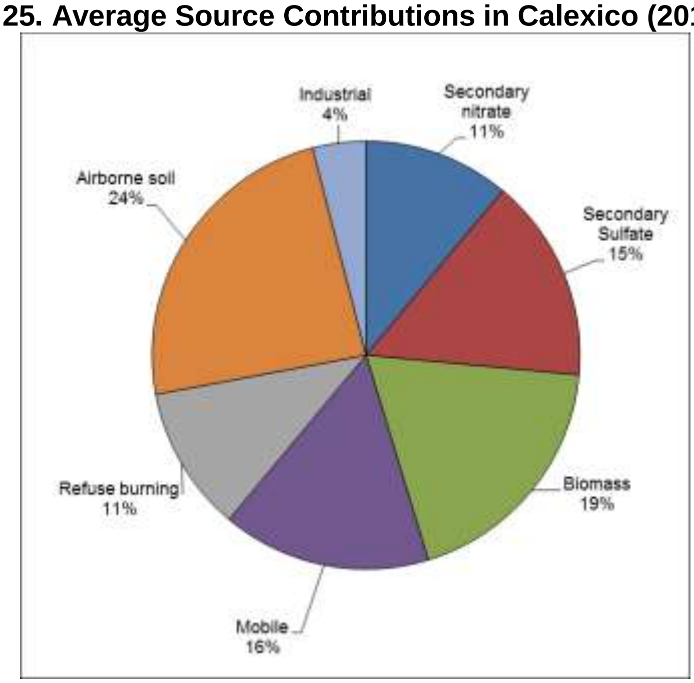


Table 13. PMF Estimate of Source Contributions to 2014 PM2.5 Annual DV

Sources	Average source contributions to 2014 PM2.5 annual DV (µg/m^3)
Airborne soil	3.4
Biomass burning	2.7
Mobile	2.3
Secondary sulfate	2.2
Secondary nitrate	1.6
Refuse burning	1.6
Industrial	0.6

Airborne soil was determined to account for 24 percent of the PM2.5 at Calexico, the most of any constituent, and contributed the highest levels in the spring and fall calendar quarters when average wind speeds are elevated. Biomass burning contributed 19 percent of the PM2.5 mass and reflects field burning, residential wood burning, and cooking. High values during the winter and summer suggest a strong influence from biomass burning for space heat and field burning of crop residues, respectively (Table 14). Mobile sources exhibited a peak in winter, reflecting increased wintertime vehicular border crossings. Additional information on vehicle emissions associated with Ports-of-Entry (POEs) located in Imperial County is included in Appendix H.

Secondary sulfate exhibited elevated levels during the summer, corresponding to seasonal high photochemical activity. Secondary nitrate, accounting for 11 percent of PM2.5 mass at Calexico, peaked in the winter months corresponding to high numbers of vehicles crossing the border. Refuse burning also contributed 11 percent and includes contributions from the burning of waste materials such as polyvinyl chloride (PVC) pipes, wood scraps, and used tires. Higher contributions in winter are consistent with the wintertime bonfires that are a traditional part of Mexican festivals and holidays.

Table 14. Quarterly Source Contribution Fractions between January 2011 and August 2015

Sources	Source contribution ratio			
	Quarter 1 (Jan-Mar)	Quarter 2 (Apr-Jun)	Quarter 3 (Jul-Sep)	Quarter 4 (Oct-Dec)
Airborne soil	0.20	0.26	0.22	0.27
Biomass burning	0.18	0.20	0.18	0.20
Mobile	0.23	0.11	0.10	0.19
Secondary sulfate	0.06	0.20	0.29	0.08
Secondary nitrate	0.19	0.07	0.05	0.12
Refuse burning	0.12	0.11	0.09	0.12
Industrial	0.03	0.06	0.07	0.02

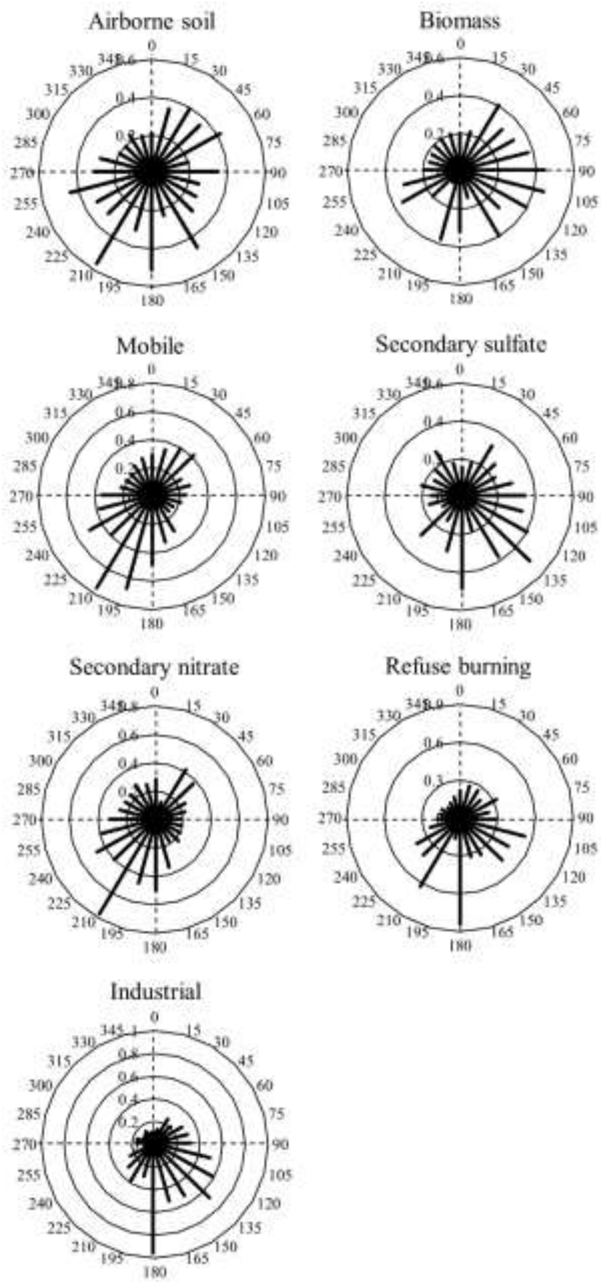
Industrial sources with elevated concentrations of iron (Fe), lead (Pb), and zinc (Zn), accounted for 4 percent of PM2.5. Potential industrial sources of these metals have been identified in Mexicali and include metal processing operations, brick kilns, cement kilns, and various incinerators. PMF analysis indicates higher contributions of these elements during the summer months.

To estimate the potential directions of sources impacting the Calexico monitor, a statistical approach was used. The method calculates the fraction of the number of data points above a given threshold from a particular wind direction arc to the total number of data points originating from the same wind direction. The resulting conditional probability function, or CPF, was calculated using source contribution estimates from PMF coupled with wind direction values measured at the Calexico station. Refer to Appendix C for more detailed information on CPF and its application in identifying the directionality of emission sources impacting Calexico.

The CPF analysis for airborne soil points southeast, south, and southwest from Calexico suggesting high contributions from the Mexicali area (Figure 26). The CPF analyses for mobile source and secondary nitrate both show strong southwest source directionality suggesting high contributions from the Calexico West POE.[17] Both secondary sulfate and industrial source had source directionalities of south and southeast, again indicating strong Mexicali contributions. Major sources of refuse burning were also determined to be south of the Calexico monitor.

[17] Three POEs connect Imperial County and Mexico: Calexico West/Mexicali I (primarily private vehicles and pedestrians); Calexico East/Mexicali II (primarily commercial vehicles and trucks); and Andrade/Los Algodones (private vehicles and pedestrians).

Figure 26. Conditional probability function plots for the highest 25 percent of the source contributions



Significant reduction of emissions from certain PM2.5 sources categories, especially those contributing to the formation of secondary PM2.5 may not be practical within the timeframe of a Moderate area PM2.5 attainment plan. However, for the sensitivity analysis, reductions in PM2.5 DVs were estimated for various source reduction scenarios on the basis of quarterly source apportionment results at the Calexico monitor. As shown in Table 14, quarterly source contribution fractions were calculated using the source contribution estimates from PMF. Next, reduced 2014 PM2.5 DVs were estimated by applying these quarterly fractions to PM2.5 FRM data collected between 2012 and 2014.

Source apportionment and source direction analyses indicated that refuse burning and certain industrial sources, contributing 15 percent of the total PM2.5 mass in Calexico, originated from activities that are not expected to occur in Imperial County. As shown in Table 15, the PM2.5 DV for 2014 can be reduced to 12.2 $\mu g/m^3$ from 14.3 $\mu g/m^3$ if emissions from refuse burning and industrial sources were fully controlled. Since source direction analyses showed the possibility that both industrial emissions and secondary sulfate precursor emissions originated from the same facilities, industrial source control could also reduce most of the secondary sulfate precursor emissions, lowering the 2014 DV further to 10.0 $\mu g/m^3$.

Table 15. Reduction Estimations of Calexico PM2.5

Controlled Sources	Reduced 2014 PM2.5 DV ($\mu g/m^3$)	Reduction of 2014 PM2.5 DV (percent)
Refuse burning, Industrial	12.2	14.7
Refuse burning, Industrial, Secondary sulfate	10.0	30.1
Biomass burning	11.6	18.9
Biomass burning: quarter 1, quarter 4	12.9	9.8
Biomass burning: quarter 2, quarter 4	12.8	10.5
Mobile, Secondary nitrate	10.5	26.6
Mobile, Secondary nitrate: quarter 1, quarter 4	11.6	18.9

Biomass burning was found in the source apportionment analysis to be the second largest contributor to PM2.5 in Calexico and originates in the Imperial PM2.5 NA and in Mexicali. Biomass burning control alone could reduce the 2014 DV to 11.6 $\mu g/m^3$. If burning control is considered on a quarterly basis, bans in quarters 2 and 4 were found to be slightly more effective than restrictions in just the winter season, i.e., quarters 1 and 4 (see Table 15).

Since the source direction analyses showed that most of the PM2.5 from mobile sources and secondary nitrate precursor emissions impacting the Calexico monitor originated from the U.S./Mexico POEs, vehicles idling at the border is believed to be the primary source. If mobile and secondary nitrate sources were fully controlled at the border crossing area, the PM2.5 DV for 2014 might be reduced to 10.5 $\mu g/m^3$. If idling times vehicles were eliminated in the winter season (quarters 1 and 4), the 2014 Calexico PM2.5 DV might potentially drop below 12.0 $\mu g/m^3$.

XI. Summary of the Modeling Assessment for the 2017 Imperial Annual PM2.5 SIP

In support of the Imperial County $PM_{2.5}$ NA SIP for the annual standard, photochemical modeling was utilized to determine whether "but for emissions emanating from outside of the United States" (i.e., Mexicali), the County would attain the annual $PM_{2.5}$ standard of 12 µg/m^3 in 2021 with reasonable controls implemented. U.S. EPA modeling guidance (U.S. EPA, 2014)[18] outlines an approach for utilizing modeling in a relative sense to project annual $PM_{2.5}$ DVs to a future year based on the modeled $PM_{2.5}$ response to changes in anthropogenic emissions from the modeled base year to a future year. The modeling analysis in support of this SIP follows this same relative approach, but includes an additional future year modeling sensitivity, where emissions from Mexico are excluded and the future year DVs are recalculated. The resulting DV is the DV that is estimated to have occurred in the absence of anthropogenic emissions from Mexico influencing $PM_{2.5}$ levels at a given monitor. Details of this approach and analysis are described in the Modeling Assessment (Appendix D) and Modeling Protocol (Appendix E) Appendices.

Table 16 summarizes the results from the modeling assessment. The Baseline DVs listed in the table (third column) represent the average of the observed DV from 2012, 2013, and 2014 at each of the three $PM_{2.5}$ monitors in Imperial County. The remaining two columns (4-5) in the table represent future DVs when future year estimates of Mexico anthropogenic emissions are included and excluded (i.e., set to zero) and reasonable controls are in place in Imperial County. Baseline DVs for the Calexico monitor are shown to exceed the annual $PM_{2.5}$ standard of 12 µg/m^3, while both the El Centro and Brawley monitors are well below the standard. In 2021, the Calexico DV is projected to decrease 0.5 µg/m^3 down to a level of 13.7 µg/m^3, due to a combination of emission reductions in Imperial County and emission increases within Mexico. However, in the absence of Mexico emissions (i.e., all Mexico anthropogenic emissions set to zero), the future year DV drops from 13.7 µg/m^3 to below the annual standard at 11.7 µg/m^3 in Calexico. The El Centro and Brawley monitors also exhibit reduced DVs, with El Centro dropping from 7.1 µg/m^3 to 6.6 µg/m^3 and Brawley decreasing from 7.0 µg/m^3 to 6.8 µg/m^3 when Mexico emissions are excluded. These findings suggest that in the absence of anthropogenic emissions in Mexico, all monitors in Imperial County would attain the annual $PM_{2.5}$ standard given the emission reductions expected within Imperial County between 2012 and 2021.

[18] U.S. EPA, 2014, Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5 and Regional Haze, available at http://www.epa.gov/scram001/guidance/guide/Draft_O3-PM-RH_Modeling_Guidance-2014.pdf

Table 16. Future year (2021) DVs calculated with and without Mexico emissions

Site AQS ID	Site Name	Baseline DV (µg/m^3)	2021 DV (µg/m^3)	
			w/ Mexico Emissions	w/o Mexico Emissions
60250005	Calexico	14.2	13.7	11.7
60251003	El Centro	7.3	7.1	6.6
60250007	Brawley	7.4	7.0	6.8

For the detailed modeling assessment and protocol for the Imperial County PM2.5 NA SIP see Appendices D-F.

XII. Conclusions

Over the last two decades a wealth of information has been collected concerning air quality in the U.S.-Mexico border region and, in particular, the area surrounding the sister cities of Calexico, California, and Mexicali, Mexico. Much of this information centers on the differences between the two cities in terms of geographical extent, population, and the degree of urbanization among other characteristics. These differences, coupled with the topography of the Imperial-Mexicali Valley and the meteorology of the region, facilitate the channeling of air pollution across the border. The result is a binational airshed where pollutants generated on one side of the international border impact air quality on the other side.

The key differences between Calexico and Mexicali within a common airshed, together with a recognition of the impact that a larger and more emissions-intensive area might have on an area with fewer sources, provides the context for a conceptual model to help explain elevated PM2.5 levels in the Imperial County PM2.5 NA. Air quality, meteorology, and emissions data, combined with photochemical modeling outputs, were reviewed and analyzed for the 2012 to 2016 time period generally with a focus on the 2012 to 2014 DV period.

The main conclusions that were drawn from an evaluation of the measurement and modeling efforts are summarized as follows:

1) Calexico is the only monitor in the Imperial County PM2.5 NA that has a DV over the annual PM2.5 standard. DVs at the northern nonattainment area sites are below the annual standard and almost half the level of Calexico.

2) PM2.5 concentrations above the level of the annual standard occur throughout the year at Calexico, El Centro, and Brawley, although they are much less frequent at El Centro and Brawley.

3) A gradient in PM2.5 mass data is evident with the highest mass measurements recorded at the Calexico site and decreasing with increasing distance north of

the border. Between 2012 and 2015, more than half of the PM2.5 concentrations recorded at the Calexico monitoring site were over the annual standard of 12.0 µg/m^3, while less than 10 percent of the days at El Centro and Brawley experienced days over 12.0 µg/m^3.

4) A comparison of the most recent comparable Imperial County PM2.5 NA and Mexicali emission inventories for direct PM2.5 and precursors estimates suggests a split in total PM2.5 emissions with approximately 40 percent attributable to the Imperial County PM2.5 NA and 60 percent attributable to Mexicali. Despite uncertainties associated with the Mexicali inventory, the magnitude of the difference between the Imperial County PM2.5 NA and Mexicali emission inventories, combined with corresponding air quality differences, implies that the border region and the monitoring site in Calexico are heavily impacted by emissions transported across the border.

5) PM2.5 levels measured at monitoring sites in the Imperial County PM2.5 NA are affected by the distribution of wind direction. Aggregating hourly PM2.5 concentrations with wind direction indicated that that while winds from the south occurred only 23 percent of the time, their contribution to the Calexico DV was 4.5 µg/m^3. Without the influence of southern winds, and the corresponding Mexicali emissions, the Calexico monitor site would be in attainment of the annual 12.0 µg/m^3 PM2.5 standard.

6) Chemically speciated PM2.5 data collected from the Calexico monitoring station show a seasonal pattern in PM2.5 mass/components with the highest concentrations of organic matter, elemental carbon, and ammonium nitrate occurring in winter. Geological dust is the second highest contributor to PM2.5 at Calexico and remains fairly constant throughout the months, with slight increases in the fall and early winter months.

7) XRF analysis results indicate that elemental species concentrations increased with proximity to the border. The lowest values were observed at Brawley, about 22 miles north of the border, where the average concentration of non-geologic elements was 0.37 µg/m^3. Concentrations were twice as high at El Centro, about 9 miles north of the border, with an average of 0.63 µg/m^3. The non-geologic element concentrations reached a maximum at Calexico where the average sum of non-geologic elements was about 2.1 µg/m^3.

8) The gravimetric and speciation analyses show that PM2.5 samples collected in Calexico differ substantially in chemical composition from other locations around the State implicating Mexicali as the source of a large portion of the emissions impacting the Calexico monitor.

9) An emissions density analysis was used to estimate the annual average PM2.5 concentration that would exist at the Calexico station if the emission activities surrounding the station were the same as those to the north of the international

border in the absence of Mexicali emissions sources. The analysis showed that while the emission densities of Calexico, El Centro, and Brawley are essentially the same, PM2.5 air quality at the Calexico station is substantially different than the two northern sites and that the difference is most likely due to impacts from Mexicali emissions sources.

10) Source apportionment and source direction analyses indicated that refuse burning and certain industrial sources, contributing 15 percent of the total PM2.5 mass in Calexico, originated from activities that are unknown in Imperial County. Source direction analyses showed the possibility that both industrial emissions and secondary sulfate precursor emissions originated from the same facilities.

11) Controls on industrial sources, refuse burning, and secondary sulfate could lower the 2014 DV at the Calexico monitoring site to 10.0 $\mu g/m^3$.

12) Modeling results show that in the absence of anthropogenic emissions in Mexico, the annual PM2.5 DV for the Calexico monitor in 2021 will be below the annual standard at 11.7 $\mu g/m^3$.

XIII. Future Monitoring Projects

CARB continues to work on understanding air quality in Imperial County and the border region. Following is a brief summary of two monitoring projects that are currently underway which seek to evaluate the emissions in Imperial County and at the border. These projects also aim to educate the communities on the impact of air pollution in this region.

Imperial County Community Air Monitoring Project
The designation of Imperial County as nonattainment for the PM10 and PM2.5 standards, and the associated impacts to public health from high levels of these pollutants, is an issue of increasing concern to local organizations working to improve the quality of life within disadvantaged communities in Imperial County. One of these organizations, Comite Civico Del Valle, Inc. (CCDV), has partnered with the California Department of Public Health and others to operate 40 low-cost particulate matter (PM) monitors throughout low-income neighborhoods in the Imperial Valley, and to provide real-time data from these monitors to the general public.[19] To date, all of the low-cost monitors have been installed, and data from these is to be displayed on a CCDV-supported website.

Mexicali PM2.5 Monitoring Project
In 2014, U.S. EPA approved funding for a CARB proposal to have PM2.5 and meteorological parameters monitored for a two-year period in Mexicali by a contractor to enrich the limited data collected by the Baja California's Secretaria de Proteccion al

[19] Imperial County Community Air Monitoring Project, California Department of Public Health, http://www.cehtp.org/page/imperial_county (accessed May 26, 2016).

Ambiente (SPA). Monitoring under this project commenced in April 2016 at two locations in Mexicali: (1) Engineering Institute of the Autonomous University of Baja California (UABC); and, (2) Vocational School of Baja California (COBACH). UABC and COBACH are located in the urban area of Mexicali near the border, approximately 3.5 and 2.7 miles from the Calexico monitor, respectively. PM2.5 is monitored at both of these sites using continuous instruments, and speciation and carbon samplers are being operated on a 1-in-6 day schedule at the UABC station. Samples collected by the speciation and carbon samplers will be analyzed for PM2.5 constituents by CARB.

Monitoring protocols used in this project are required by the contract to mirror those used at the Calexico station as closely as possible for data comparability. In addition to real time, non-validated data submitted to AirNow, the data is now also submitted to AQMIS for easier access for some stakeholders. Reviewed and validated hourly PM2.5 mass and meteorological data continue to be submitted to the U.S. EPA air quality data repository, AQS. The monitoring portion of the contract will conclude in April 2018. Appendix J includes an analysis of the recent Mexicali data available compared to the data collected in Imperial County. A more robust analysis of all of the Mexicali air quality data from this monitoring effort will be completed once the project is complete.

Appendix A: Speciation Trends at Calexico and Filter Analysis by XRF

Speciation Trends

Background

Two different samplers and multiple filter media are used to determine chemical speciation profiles for use in assessing trends in chemical constituents associated with airborne particles with diameters smaller than 2.5 microns (PM2.5). A Spiral Ambient Speciation Sampler (SASS)[1] is used to collect PM2.5 constituents including ions (sulfate, nitrate, sodium, potassium, and ammonium) and numerous trace elements while a URG 3000N (URG)[2] sampler is designed to sample for organic and elemental carbon found in ambient PM2.5. Both speciation samplers (SASS and URG) operate on a 1-in-6 day sampling schedule. Multiple sampling media are required to measure different PM2.5 components. PM2.5 gravimetric mass and elements are measured by X-Ray Fluorescence (XRF) on Teflon®-membrane filters. Ions are measured by ion chromatography on nylon-membrane filters. Organic and elemental carbon (OC and EC, respectively) are measured by Total Optical Reflectance (TOR) method on quartz-fiber filters.

The data are analyzed by CARB's Monitoring and Laboratory Division and reported to U.S. EPA's Air Quality System (AQS) database. Currently applied laboratory measurement techniques do not quantify all measured components; therefore, the sum of the measured species is numerically less than the measured mass. CARB staff routinely use a PM mass reconstruction technique, which applies multipliers to measured species to estimate the unmeasured components. In order to reconstruct PM2.5 mass concentrations using chemical composition data, assumptions about the molecular form of the species are made. Table A-1 presents these assumptions as used in this report. For example, sulfate and nitrate are assumed to be neutralized to ammonium sulfate [$(NH_4)_2SO_4$] and ammonium nitrate (NH_4NO_3), respectively, with the NH_4^+ fraction accounted for by applying stoichiometric multipliers as specified in Table A-1.

Organic matter is a complex mixture of hundreds of individual compounds with varying composition and concentrations. One of the principal sources of uncertainty in PM2.5 mass reconstruction is the OC to organic matter (OM) conversion factor. Thermal optical methods are used to estimate the OC on the PM2.5 filter. These methods, however, quantify only the carbon present in the samples, and not the total OM, which can include hydrogen, oxygen, nitrogen, and other elements in addition to carbon. Multiplicative factors have been used to estimate OM from OC measurements, but these factors represent averages and can vary substantially depending on the location or the season. In order to estimate the OM, CARB staff use a previously published

[1] Developed by Met One Instruments, Inc. (MetOne)
[2] Developed by University Research Glassware Corporation (URG)

value of 1.4, widely used in previous work in California.[3,4,5] To correct for possible OC sampling artifacts, the site-specific monthly median of a field blank filter is subtracted from measured OC prior to converting to OM. Elemental carbon is used without any multipliers. Geologic material is estimated following the formula utilized by the Interagency Monitoring of PROtected Environments (IMPROVE) Program and is generally composed of dust. The elements component is estimated by summing the remaining elements measured by XRF, excluding sulfur and geological elements. Reconstructed mass is then expressed as the sum of its representative chemical components, including ammonium nitrate, ammonium sulfate, organic matter, elemental carbon, geological material, and trace elements.

Table A-1. Assumed Form of Molecular Species

Component	Formula
Ammonium Nitrate	1.29 x Nitrate
Ammonium Sulfate	1.38 x Sulfate
Organic Matter	1.4 x Organic Carbon
EC	As measured
Geologic	2.2 x Aluminum + 2.49 x Silicon + 1.63 x Calcium + 2.42 x Iron + 1.94 x Titanium
Elements	Sum of remaining species (excluding S, Al, Si, Ca, Fe, and Ti)

PM2.5 speciation data between January 2013 and August 2014 were invalidated due to a flow rate problem with the SASS unit. Speciation data collected from 2010 to 2012 were therefore evaluated in substitute.[6] Because CARB staff would not anticipate any significant change in the source profile impacting the Calexico sampler from 2010 to 2012 and from 2013 through mid-2014, the presence of specific elements or chemical composition data that would help determine a particular type of emission source are expected to be the same for the substitute data as they would be for the invalidated data.

PM2.5 Composition

Compositional analysis showed that PM2.5 at Calexico for 2010 to 2012 was composed primarily of organic matter and, to a lesser extent, geologic material (see Figure A-1).

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[3] Solomon, P. A., Fall, T., Salmon, L. G., Cass, G. R., Gray, H. A., and Davidson, A. 1989. Chemical Characteristics of PM10 Aerosols Collected in the Los Angeles Area *J. Air. Pollut. Control Assoc.* 39:154-163.
[4] Chow, J.C.; Watson, J.G.; Fujita, E.M.; Lu, Z.; Lawson, D.R.; Ashbaugh, L.L. (1994). Temporal and spatial variations of PM2.5 and PM10 aerosol in the Southern California Air Quality Study. *Atmos. Environ.*, 28(12):2061-2080.
[5] Chow, J.C.; Watson, J.G.; Lu, Z.; Lowenthal, D.H.; Frazier, C.A.; Solomon, P.A.; Thuillier, R.H.; Magliano, K.L. (1996). Descriptive analysis of PM2.5 and PM10 at regionally representative locations during SJVAQS/AUSPEX. *Atmos. Environ*., 30(12):2079-2112.
[6] See Appendix C for detail on data screening technique that resulted in speciation data invalidation for the period January 2013 through August 2014.

Analysis indicates the particulate matter is predominantly composed of carbonaceous aerosols (OM plus EC), which comprise about 45 percent of the PM2.5 mass on average between 2010 and 2012. Since most of carbonaceous aerosol particles originate from combustion sources such as tailpipe emissions, wood burning, and the like, a specific winter-high pattern becomes evident. Figure A-2 illustrates this pattern with the carbonaceous aerosol peak in winter and a lower, relatively constant, pattern throughout the rest of the year. This pattern is consistent with known activity patterns along the U.S.-Mexico border in Imperial County.

Ammonium nitrate and ammonium sulfate also contribute a large share of PM2.5 at Calexico. Ammonium nitrate concentrations are elevated in winter and are formed from the reaction of ammonia and nitric acid (Figure A-2), particularly in cooler temperatures. In contrast, ammonium sulfate is highest in the summer months and is a reaction of ammonia and sulfuric acid.

Figure A-1. Calexico 2010-2012 Average Composition

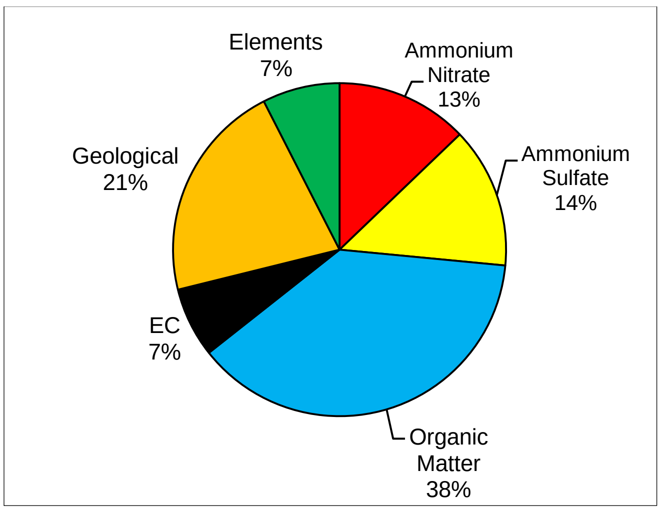
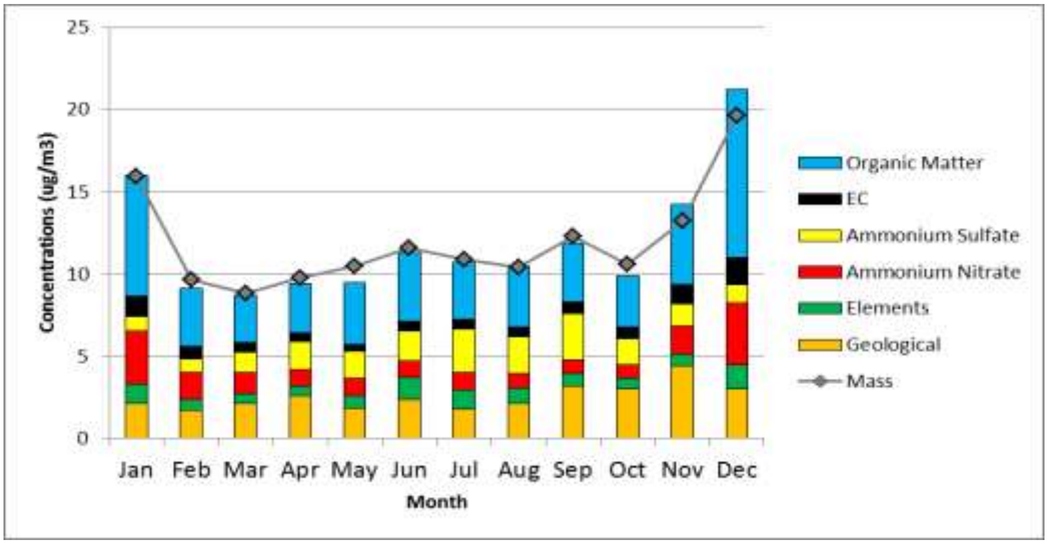


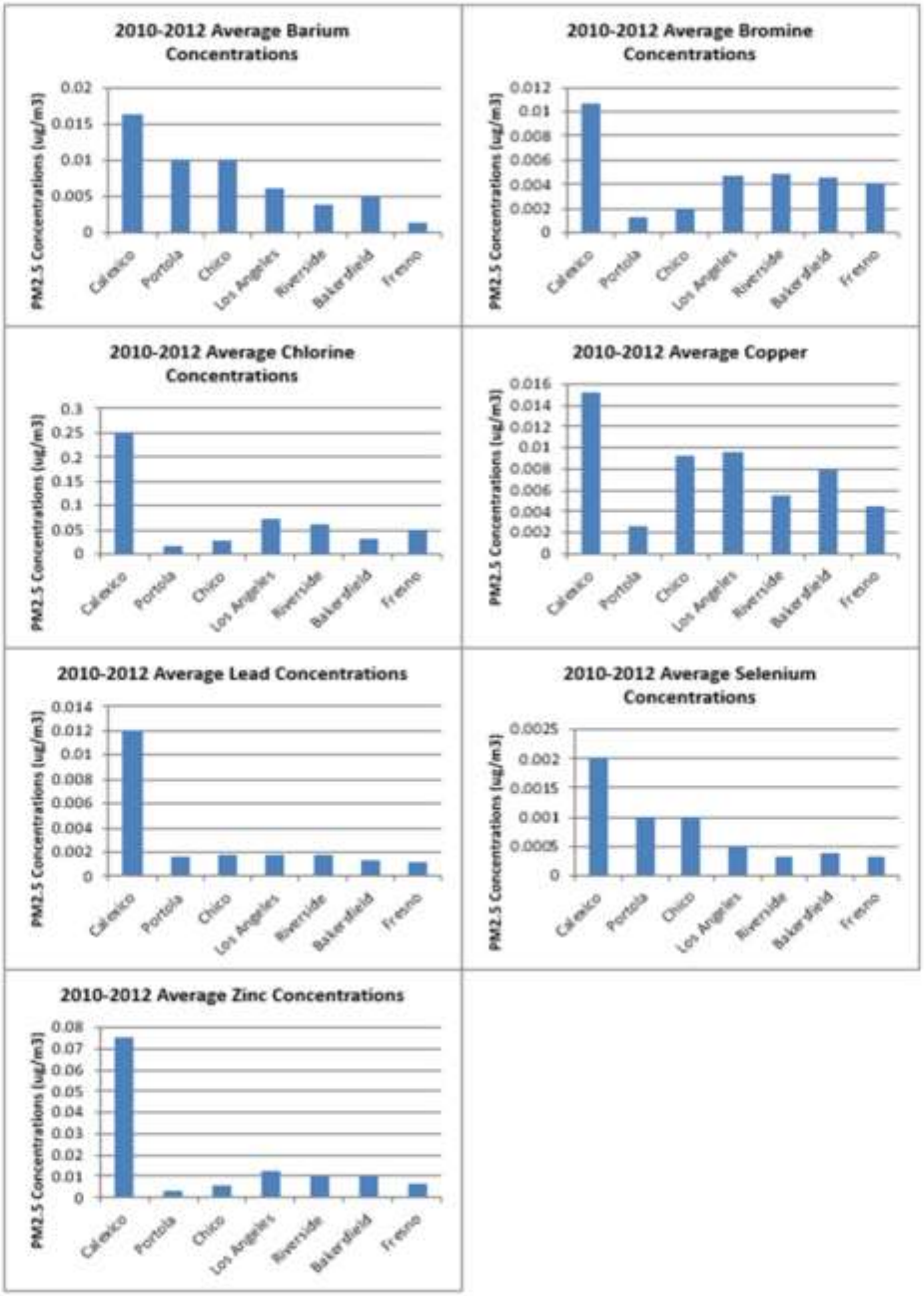
Figure A-2 illustrates the seasonal pattern in PM2.5 mass as well as chemical constituents at the Calexico site with the highest concentrations occurring during the winter months, mainly due to increases in organic matter, elemental carbon, and ammonium nitrate. Geologic material (dust) is the second highest contributor to measured PM2.5 at the Calexico monitor due in part to the presence of large expanses of desert and other open areas in the region. Geologic material remains fairly constant throughout the months, with slight increases in the fall and early winter months.

Figure A-2. PM2.5 Monthly Average Chemical Composition at Calexico (2010-2012)



To evaluate the speciation data from Calexico in the context of speciation data collected at other locations in California, CARB staff performed a comparative analysis and noted both similarities and differences in the speciation profiles. Figure A-3 compares barium, bromine, chlorine, copper, lead, selenium, and zinc to concentrations from other sites in the state. These elemental components measured two to twenty-two times higher at Calexico than at other sites in California. Strict environmental controls on industrial emissions, emissions from the transportation sector, and waste disposal result in relatively low concentrations of these elements within the state. Given the proximity of the Calexico monitoring site to the border, coupled with anecdotal evidence that environmental regulations are not as stringent in Mexico, posits the principle that concentrations of elemental species are most likely high in Mexico and are transported across the border impacted the Calexico air monitoring site.

Figure A-3. 2010-2012 Average Concentrations of Select Elemental Species

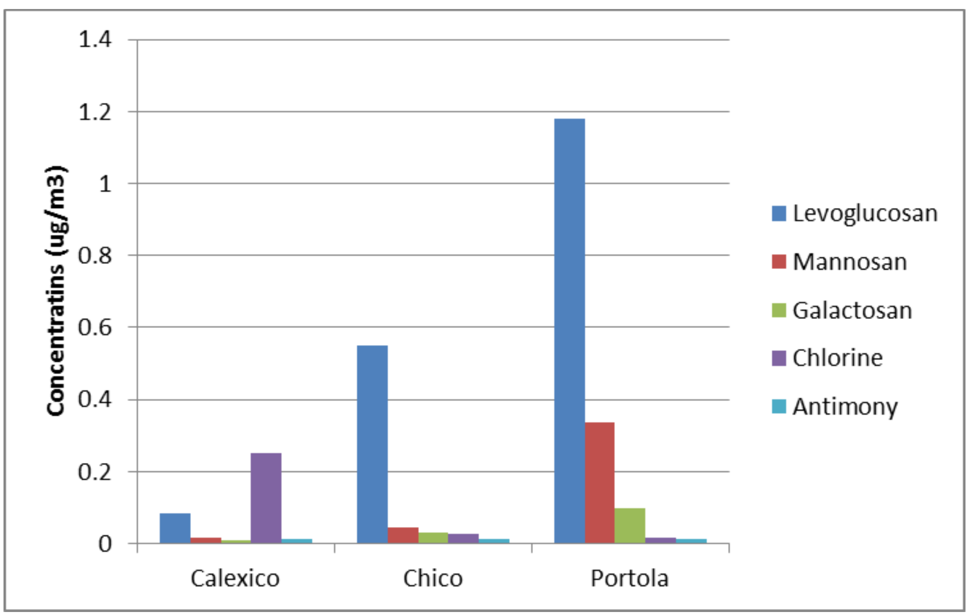


Apart from elemental species, the presence of several other compounds is potentially useful in assessing the origin of emissions measured at the Calexico station. Levoglucosan, mannosan, and galactosan are combustion byproducts of cellulose and are often used as tracers for identifying biomass combustion. CARB staff evaluated the Calexico speciation data for these tracers to further help in identifying the type of combustion emissions impacting the Calexico monitor. Areas with wood burning activity generally have elevated levels of all three tracers. The City of Portola in Plumas County and the City of Chico in Butte County, for example, are areas with elevated wood smoke and are known to have increased concentrations of cellulosic byproducts. At the Calexico station, measured concentrations of levoglucosan are elevated, but still up to 70 percent lower compared to other areas of the state with documented high levels of residential and other wood combustion activities. Similarly, concentrations of mannosan and galactosan are substantially lower at Calexico compared to Chico and Portola.

Higher concentrations of galactosan in a community impacted by wood burning are consistent with research indicating that galactosan is a key marker for wood burning. The burning of refuse, which often contains paper, cardboard, and plastic does not generate high levels of galactosan, but instead may generate antimony and chlorine.[7] Chlorine is present in most household waste, including paper products. The very low concentrations of galactosan observed at Calexico, coupled with unusually high concentrations of chlorine, help rule out the typical residential or agricultural wood combustion as a probable source of the high PM2.5 concentrations at the Calexico monitor (Figure A-4).

These analyses of wood burning tracers substantiate the idea that emissions impacting Calexico are atypical of simple wood burning and more likely indicate combustion associated with burning household waste also referred to as refuse burning.

Figure A-4. Comparison of Wood Burning Markers at Cities of Calexico, Chico, and Portola (2010-2012 averages)



[7] Christian, T. J.; Yokelson, R. J.; Cárdenas, B.; Molina, L. T.; Engling, G.; Hsu, S.-C.: Trace gas and particle emissions from domestic and industrial biofuel use and garbage burning in central Mexico, *Atmos. Chem. Phys*., 10, 565–584, 2010.

PM2.5 Filter Analysis by X-Ray Fluorescence (XRF)

Background

The objective of this analysis was to compare the elemental species concentrations at the three Imperial County PM2.5 sites. The operating assumption for the analysis was that since the three air monitoring sites are in locations with similar land use and populations, they should have comparable PM2.5 elemental compositions. Although Calexico is the only monitoring site in Imperial County that routinely collects speciation data, the XRF analysis of filters from PM2.5 FRM samplers collected at all three sites could be used to validate that assumption. Elemental species are proven tracers and are extensively used to identify sources of emissions. Non-geologic elements in particular are useful tracers of anthropogenic activities including industrial sources, high polluting cars and fuels, and garbage burning and other modes of improper waste disposal.[8]

Listed below are several examples of non-geologic PM2.5 markers and their potential sources.

- Selenium – incineration of paper products, combustion of industrial and residential fuels, and refinery waste gases and fumes;
- Lead – waste incineration, ore and metal processing, utilities, and lead-acid battery manufacturing;
- Chlorine – plastic waste burning, industrial liquefaction processes and other industrial uses;
- Zinc – incineration, refineries, brass manufacturing processes, and zinc galvanizing;
- Manganese – incineration of manganese containing products, production of ferromanganese compounds, use of organic manganese fuel additives, and welding rod use.

For this analysis, X-Ray Fluorescence (XRF) was used to analyze 51 filters from PM2.5 Federal Reference Method (FRM) samplers.[9] As listed in Table A-2, the filters were selected to include all seasons and represent a wide range of concentrations, from approximately 9 µg/m^3 to almost 65 µg/m^3. Only filters meeting the following conditions were considered for this analysis:

1) Filters were from the same sampling day at each of the three sites;

2) Reasonably good agreement between two PM2.5 mass measurements at Calexico (FRM and SAAS) on the same day;

[8] For purposes of the XRF analysis, geologic elements refer to those listed in Table A-1, i.e., aluminum, calcium, iron, silicon, and titanium.

[9] 17 filters used in FRM samplers at each of three air monitoring sites in Imperial County – Calexico, Brawley, and El Centro – were analyzed using XRF for a total of 51 filters.

3) Sum of elemental species at Calexico was at least 0.9 µg/m^3 – focus analysis on potential cross-border transport days.

Table A-2. Elemental Species Concentrations from PM2.5 FRM Sampler Filters Selected for XRF analysis (µg/m^3)

Sampling Date	Concentration Category (µg/m^3)	Calexico	El Centro	Brawley
9/25/13	<15	9.3	4.4	9.1
4/17/14	<15	11	6.8	6.4
8/12/14	<15	11.9	8.2	7.1
7/27/13	<15	12.2	7.8	7.9
8/20/13	<15	12.6	9.1	8.2
10/20/14	<15	13.9	8.2	6
9/12/12	15-35	15.7	11.3	11.4
6/9/13	15-35	17.2	16.3	10.9
5/29/14	15-35	20.2	7.8	6.5
11/26/12	15-35	23.9	15.1	13.9
12/18/13	15-35	26	13.5	10.2
2/16/14	15-35	32.9	21.2	24.3
1/31/12	Above 35	37.7	13	22.7
1/23/14	Above 35	38.6	16.2	12.3
12/11/11	Above 35	44.4	13.7	10.2
12/4/10	Above 35	50.9	12.2	16.2
12/23/12	Above 35	64.7	26.4	15.5

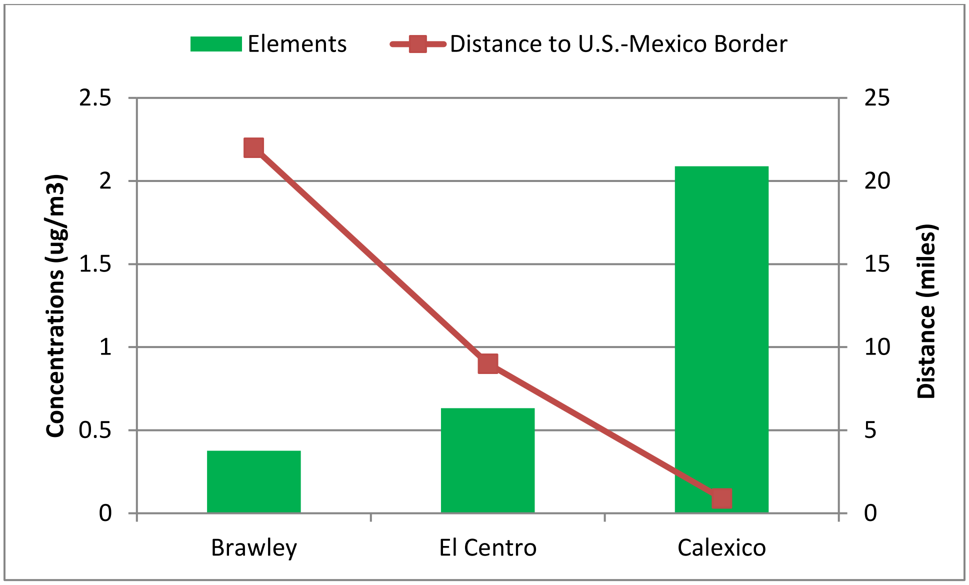
<u>XRF Analysis</u>

XRF analysis show that non-geological elemental species concentrations increased with proximity to the U.S.-Mexico border. The site with the lowest concentrations of non-geologic elemental species was Brawley, about 22 miles north of the border, where the average concentration of non-geologic elements was 0.37 µg/m^3. El Centro, located between Brawley and Calexico had concentrations approximately twice as high, with an average of 0.63 µg/m^3. The non-geologic element concentrations increased significantly closer to the border and reached a maximum at Calexico where the average sum of non-geologic elements was 2.09 µg/m^3.

Figure A-5 compares the concentrations of non-geologic elemental species at the three sites. The levels observed at Calexico were substantially higher, indicating that activities unique to this location make a significant contribution to PM2.5 levels. The Calexico monitoring station is about 0.9 miles from the border and is likely impacted by activities taking place in the vicinity of the site south of U.S.-Mexico border, including industrial activities and garbage burning. Non-geologic elemental species concentrations at Calexico site were nearly four and six times higher than El Centro and

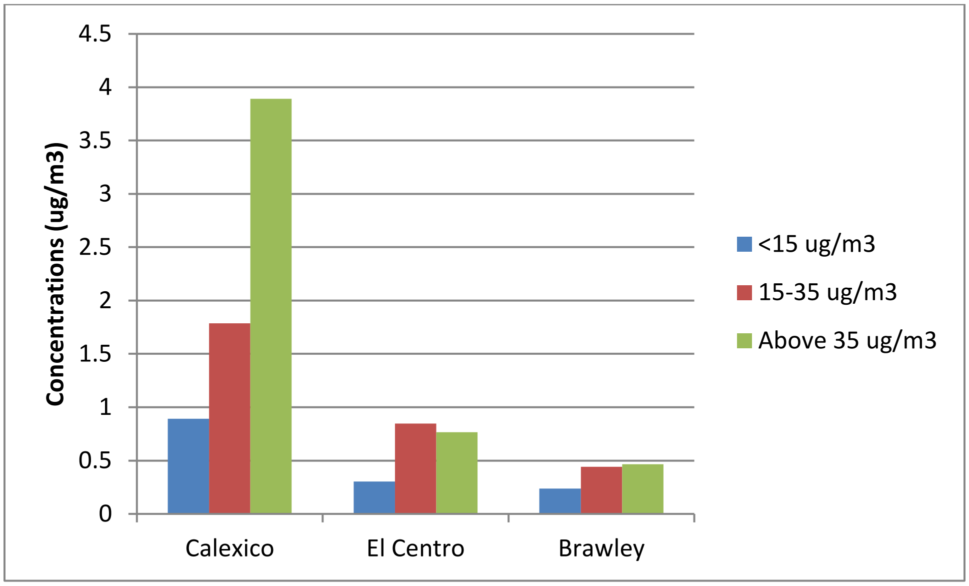
Brawley, respectively, suggesting that the main pathway for measurement of non-geologic elements at the Calexico site is via transport from Mexico.

Figure A-5. Concentrations of Non-Geologic Elemental Species (Average Based on 17 Samples)



Additional data evaluation provided evidence that associates elevated PM2.5 mass with non-geologic elemental species. By separating the PM2.5 concentrations into three different bins – less than 15 µg/m^3, 15 to 35 µg/m^3, and greater than 35 µg/m^3 – CARB staff found that the higher PM2.5 concentrations contained more elemental species (Figure A-6). This finding supports the hypothesis that cross border activities likely impact PM2.5 concentrations at Calexico.

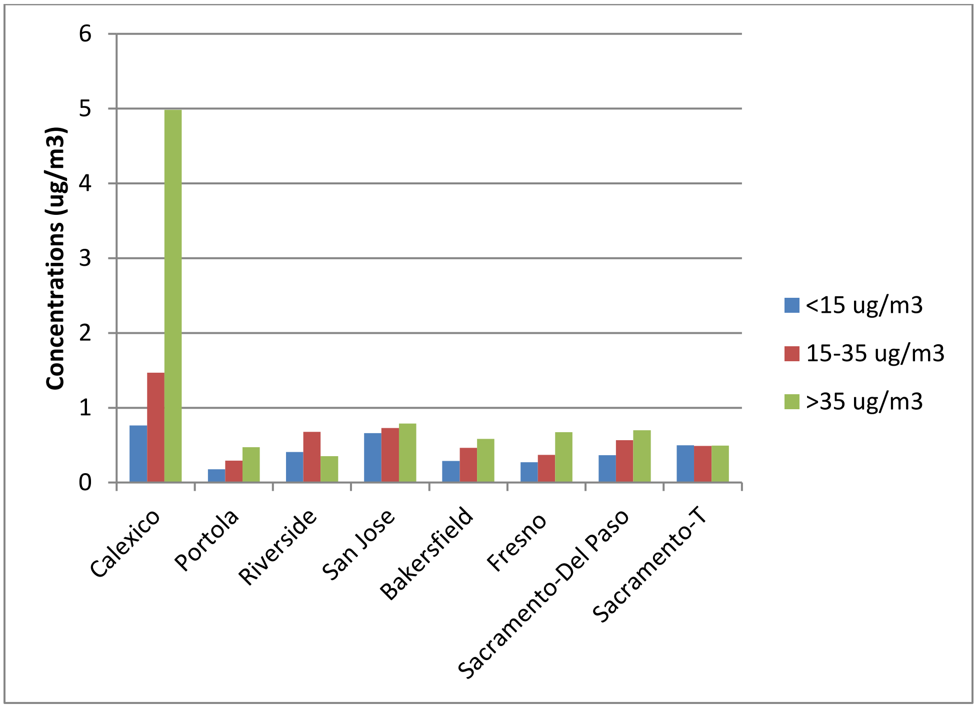
Figure A-6. Binned Concentrations of Non-Geologic Elemental Species (Averages Based on 17 Samples)



The increase in PM2.5 concentrations at Calexico from the less than 15 µg/m^3 range to the 15-35 µg/m^3 range corresponds to smaller increases of non-geologic elemental species at El Centro and Brawley. Although there was a large increase in Calexico concentrations from the 15-35 µg/m^3 range to above 35 µg/m^3, there was no corresponding impact on elemental species concentrations at the other sites. This suggests that emission sources contributing to elevated PM2.5 concentrations at Calexico have limited impact on the other two sites in Imperial County.

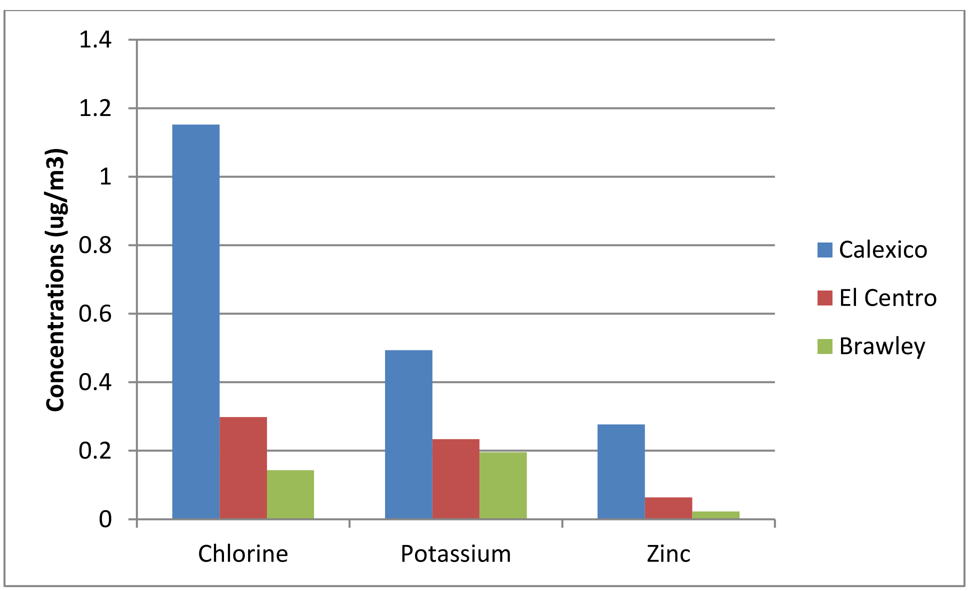
The levels of non-geological element concentrations measured at El Centro and Brawley and the slight increase seen with the increase in the magnitude of total PM2.5 mass concentrations is consistent with observations at other sites in California (Figure A-7). Both the non-geologic concentrations measured at Calexico and the significant increases with higher PM2.5 mass concentrations are unique to this site. This finding again suggests that industrial operations and waste disposal activities in Mexico are likely significant contributors to elevated PM2.5 concentrations measured at Calexico. While other California sites exhibit some increases in concentrations of non-geologic elemental species with increases in PM2.5 concentrations, the increases are very small; other factors are likely contributing to the high elemental species concentrations at these sites.

Figure A-7. Concentrations of Non-Geologic Elemental Species at Various California Sites (2012 - 2014)



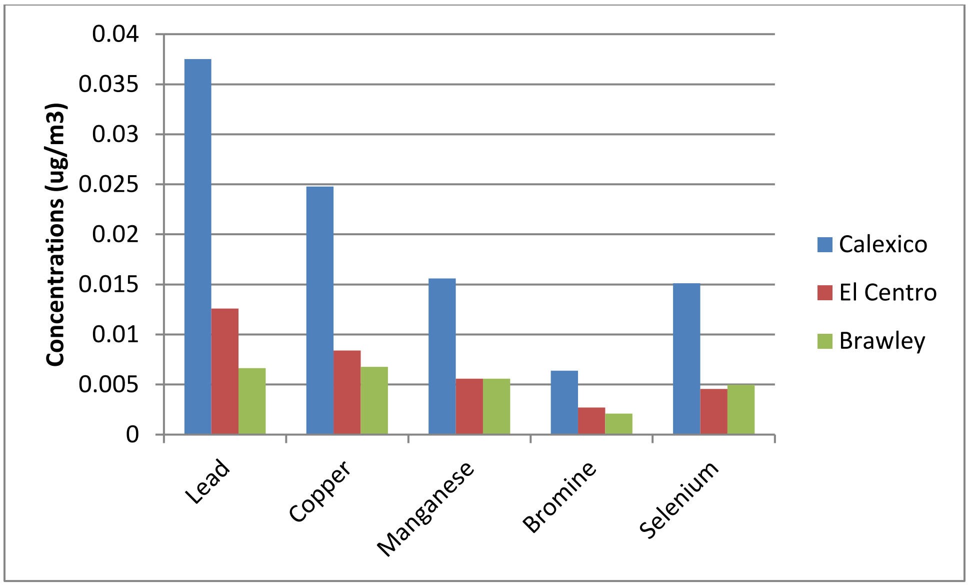
The most abundant non-geologic elements in Calexico samples were chlorine, potassium, and zinc with average concentrations of 1.2 µg/m^3, 0.5 µg/m^3, and 0.3 µg/m^3, respectively (Figure A-8). Concentrations of these species were up to 12 times higher than at the other two Imperial County sites.

Figure A-8. Average Concentrations for the Most Abundant PM2.5 Species (Average Based on 17 Samples)



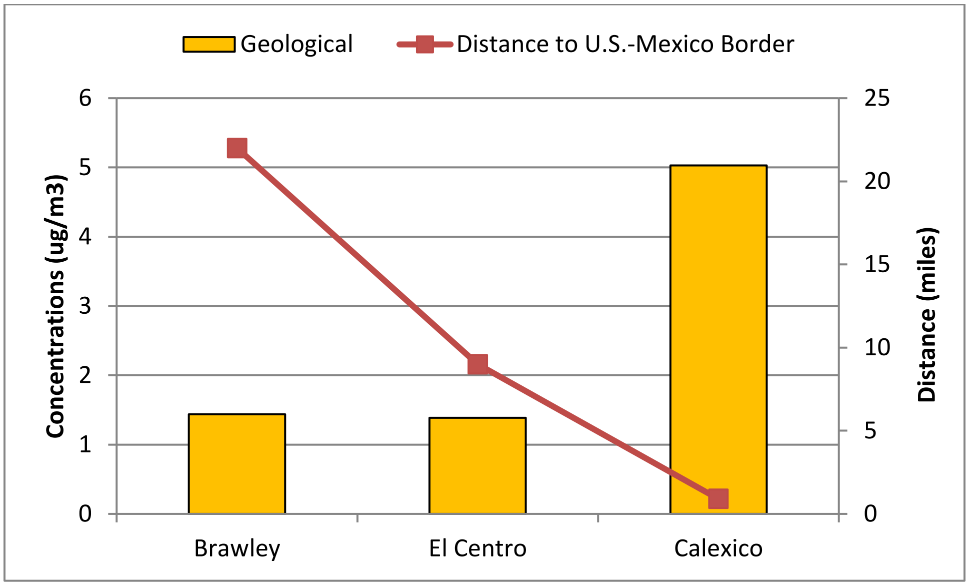
Other species with significant levels in Imperial County samples were lead, copper, manganese, bromine, and selenium (Figure A-9). Again, their concentrations were highest near the border and decreased with increasing distance to the north. On average, concentrations at Calexico were three times higher compared to El Centro and four times higher compared to Brawley.

Figure A-9. Concentrations of Select Elemental Species (Average Based on 17 Samples)



Concentrations of geologic material were also highest at Calexico (Figure A-10). Concentrations at the other two Imperial County sites, Brawley and El Centro, were approximately 70 percent lower. The elevated concentrations of geologic material may be due to emissions from unpaved roads or other open areas south of the border.

Figure A-10. Concentrations of Geological Species
(Average Based on 17 Samples)



Appendix B: Emissions Density Comparison

Introduction

Because of the similarities in emission source patterns in areas surrounding the Calexico, El Centro, and Brawley monitoring stations, and the dissimilarities in PM2.5 annual average concentrations recorded at the Calexico station compared to those at the El Centro and Brawley stations, an analysis of the relationships between PM2.5 emission inventories and air quality in these three communities was conducted. The objective of this analysis was to estimate the annual average PM2.5 concentration that would exist at the Calexico station if the emission source patterns surrounding the station were limited to those to the north of the international border, i.e., in the absence of Mexicali emission sources.

Background

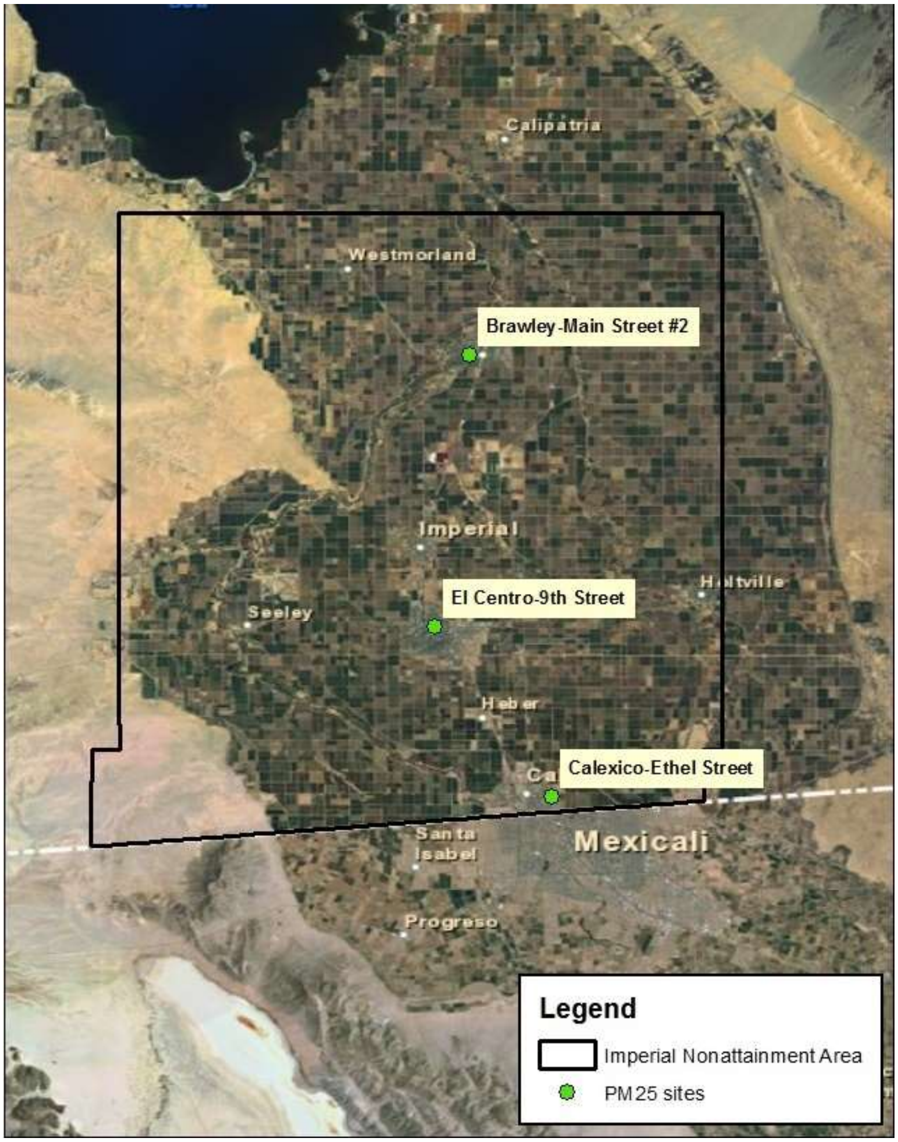
Examination of simultaneous PM2.5 measurements recorded during the 2012-2014 baseline period at the three monitoring stations (Calexico, El Centro, and Brawley) within the Imperial County PM2.5 Nonattainment Area almost invariably show substantially higher values at the Calexico station (Table B-1). Although more recent PM2.5 monitoring data are available, this analysis used data from the 2012 monitoring period as this was the year for which the most recent gridded emissions inventory data were available for comparative analysis.

Table B-1. 2012-2014 Annual Average PM2.5 FRM Concentrations

	Annual Average PM2.5, µg/m^3		
Monitoring Station	**2012**	**2013**	**2014**
Brawley	8.1	7.2	7.3
El Centro	7.5	7.0	6.6
Calexico	15.8	13.3	13.8

Several analyses presented in the 2013 Imperial County 24-Hour PM2.5 SIP, and others presented in this Appendix, point to emissions from sources situated on the Mexican side of the international border as the cause of this difference. However, the lack of a comprehensive Mexicali emission inventory and air quality monitoring data prevents an accurate accounting of impacts from these sources on Calexico PM2.5 concentrations. In recognition of these deficiencies, U.S. EPA has funded both emission inventory update and multi-year PM2.5 monitoring projects, but the data from these projects will not be available in time to incorporate into this analysis. A satellite image of the PM2.5 nonattainment area with the locations of the three Imperial County PM2.5 monitoring stations highlighted appears in Figure B-1.

Figure B-1. Imperial County PM2.5 Nonattainment Area Boundary and Monitoring Station Locations



The similarities in the annual average PM2.5 values recorded at El Centro and Brawley suggest similarities in the emissions strengths of sources impacting each monitor, given that meteorological conditions at these two stations spaced 13 miles apart are relatively similar. Both communities share similar economies (retail and service centers for a surrounding area devoted to agricultural production) and have moderately small populations (44,847 in El Centro and 26,273 in Brawley).[1] The two communities also share the same emission sector characteristics: rural light and heavy duty vehicle traffic volumes, limited industrial emissions (23.8 and 16.3 tons per year of directly-emitted

[1] California Department of Finance, Demographic Research Unit, Report E-1: Population Estimates for Cities, Counties, and the State, January 1, 2014 and 2015, Released May 1, 2015, http://www.dof.ca.gov/Forecasting/Demographics/Estimates/E-1/, accessed on January 11, 2016.

PM2.5 in El Centro and Brawley, respectively),[2] and extensive agricultural cultivation activities on the lands surrounding each community. By comparison, Calexico has a population of 38,572 and industrial PM2.5 emissions of 0.0 tons per day.

Emission Source Patterns

Contrasting the emission source patterns of El Centro and Brawley to that of Calexico revealed unexpected similarities and one very significant difference. By virtue of its historical function as a retail center serving the international border crossing from Mexicali, the capital of Baja California, into the United States, Calexico is essentially a neighborhood within the Mexicali metropolitan area, albeit one with different environmental regulations and different cultural traditions. When viewed from the international border looking north, Calexico shares the same emission source characteristics as El Centro and Brawley: generally rural vehicle traffic volumes (with the exception of cross-border traffic), limited industrial emissions, and extensive agricultural cultivation activities on the surrounding lands lying within the United States.

The significant difference in the Calexico emission source pattern from those of El Centro and Brawley becomes apparent when looking south of the shared international border into the much more populous City of Mexicali (730,800 population in 2014).[3] Here, more than 100 assembly plants (*maquiladoras*) employ tens of thousands of semi-skilled workers to assemble duty-free imported parts and components into consumer products for export and sale in the United States. In Mexicali, a significant fraction of vehicle-miles travelled occurs on unpaved roads, and the disposal of combustible rubbish by open burning remains an accepted practice. Comprehensive and accurate estimates of total emissions from sources in Mexicali, however, like ambient air quality monitoring data collected south of the border, remain elusive. The sparse data that have been reported lack adequate documentation.

Methodology

Emission inventories have been prepared for the Imperial County area to satisfy a number of SIP regulatory requirements – an accurate and comprehensive inventory for the entire area, an inventory for air quality modeling use, and inventory projections for Reasonable Further Progress tracking and attainment demonstration purposes. The most detailed emission inventory specific to the PM2.5 nonattainment area was prepared on a spatially gridded basis for air quality modeling using CARB's photo-chemical models. This inventory contains calendar year 2012 hourly emission rates for each of the PM2.5 species, which were summed spatially over modeling grid cells measuring 4 kilometers (km) by 4 km. The modeling domain for which this inventory was developed covers all of southern California and small portions of western Nevada, western Arizona, and northern Mexico. Because of this level of detail, the SIP modeling emission inventory was used in this inventory and air quality analysis.

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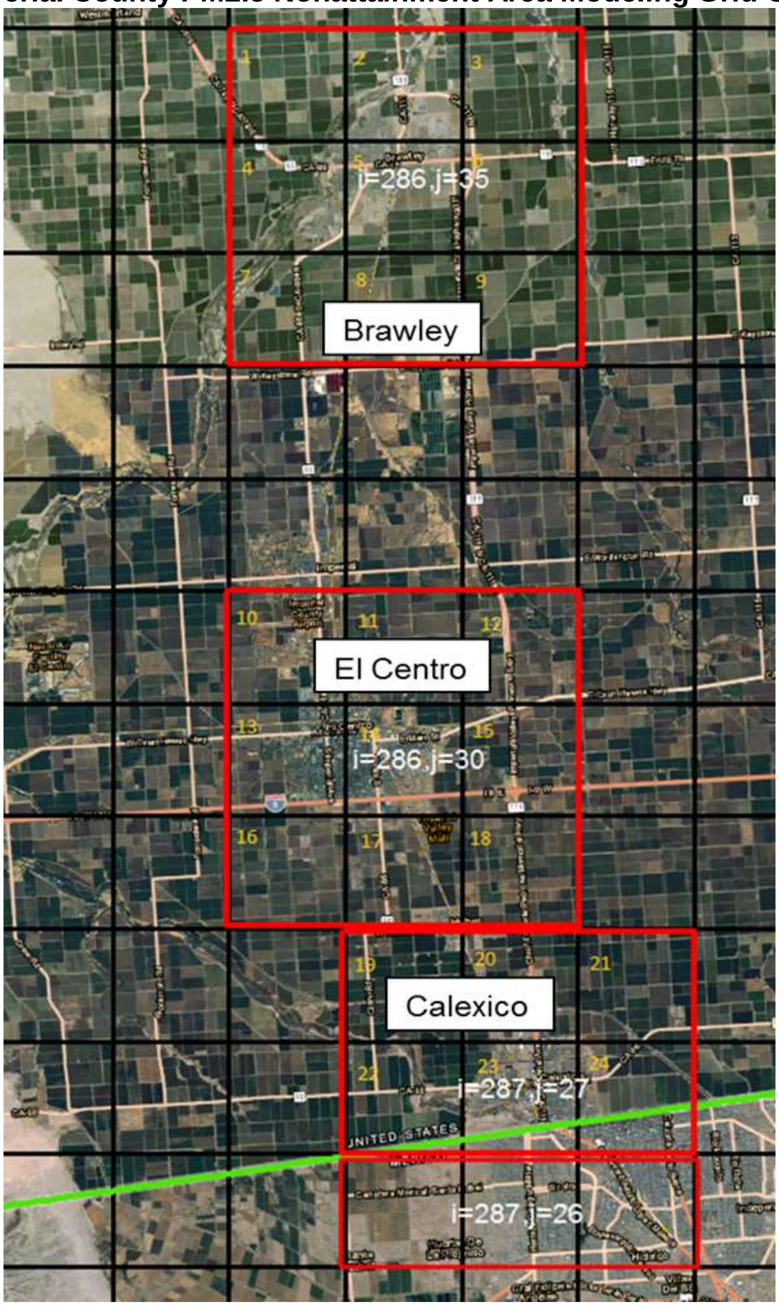
[2] CARB California Emissions Inventory Development and Reporting System (CEIDARS) v2.5.
[3] Population.City – Mexicali, http://population.city/mexico/mexicali/, accessed on December 28, 2018.

The determination of spatial boundaries encompassing the largest numbers of emission sources impacting each of the three monitoring stations was the first task in assembling community-specific inventories. A review of the locations of modeling grid cell boundaries within the PM2.5 nonattainment area was the starting point for this work. An image of the grid cell boundaries overlaid on a Google Earth satellite photograph of the three communities is shown in Figure B-2.

Figure B-2. Imperial County PM2.5 Nonattainment Area Modeling Grid Cell Boundaries



The initial review of the map in Figure B-2 revealed that the urbanized portions of each of the three communities being studied lay almost entirely within single 4 km x 4 km modeling grid cells. Additionally, when the rings of immediately-adjacent grid cells were added to the urbanized community cells to create community-specific emission inventory domains, the resulting three domains, shown in red outline, were found to be equal sized and non-overlapping, with the urbanized centers located generally in the center grid cells of these resultant 12 km by 12 km inventory domains.   This configuration of inventory domains was deemed to be appropriate for minimizing bias in the comparison of emission inventories responsible for the majority of impacts at each of the three PM2.5 monitoring stations.

Since the international border lies approximately 0.7 miles south the Calexico monitoring station, the 12 km by 12 km inventory domain for the Calexico station extends south of the border into Mexico. In Figure B-2, the international border can be seen as the green line near the bottom of the image. The three southern-most modeling grid cells in the Calexico inventory domain lie entirely within the Mexicali metropolitan area. When excluding these three cells from the domain, the emission source pattern in the remaining six grid cells looks very similar in source distribution to those surrounding the El Centro and Brawley stations. A small sliver of Mexican territory lies within the three grid cells lying along the line east and west of the Calexico station, occupying approximately 21 percent, or 10.2 km^2, of the land area of these three grid cells combined. To assure that emissions from sources within this sliver are excluded from the Calexico inventory domain, the emissions from Mexican sources that were originally allocated to each of these grid cells was subtracted from the 2012 baseline cell inventories to reduce cell emissions to only those produced by sources on the U.S. side of the international border.

After adjusting emissions in each of the three modeling grid cells straddling the international border by the subtraction of Mexicali source emissions, the emissions within each of the 24 modeling grid cells within community inventory domains were averaged and summed to produce annual average hourly PM2.5 emissions per grid cell. In this process, the hourly-specific emission rates for each hour of the year were averaged over the 2012 baseline year to derive annual average hourly emissions rates by PM2.5 species and by grid cell. Then, the species-specific annual average emissions rates were summed to derive total average hourly PM2.5 emissions per grid cell. In the next step, the grid cell-specific total PM2.5 emissions were summed over the 9 grid cells surrounding each of the Brawley and El Centro stations, and summed over the 6 adjusted grid cells surrounding the Calexico station, to produce hourly-average total PM2.5 emissions for each of the three community inventory domains. The values produced by each of these calculation steps, after the averaging of hourly emission rates to produce annual average hourly values, are presented in Table B-2.

Table B-2. 2012 Hourly Average PM2.5 Species Emissions by 4 km x 4 km Modeling Grid Cell, kg/hr

Station	Cell#	PAL	PCA	PCL	PEC	PFE	PK	PMG	PMN	PMOTHR	PNA	PNCOM	PNH4	PNO3	POC	PSI	PSO4	PTI	Sum
Brawley	1	0.27	0.11	0.02	0.08	0.21	0.08	0.03	0.00	1.36	0.02	0.07	3.97	0.05	0.33	0.69	0.04	0.18	7.52
	2	0.22	0.09	0.26	0.26	0.17	0.25	0.02	0.00	1.17	0.02	0.12	2.11	0.05	0.67	0.56	0.09	0.10	6.15
	3	0.33	0.13	0.06	0.11	0.25	0.13	0.02	0.00	1.65	0.02	0.08	3.43	0.04	0.39	0.83	0.05	0.16	7.71
	4	1.39	0.62	0.04	0.24	1.08	0.41	0.11	0.02	7.76	0.09	0.58	17.74	0.42	2.17	3.53	0.24	0.80	37.25
	5	0.51	0.22	0.03	0.34	0.41	0.17	0.04	0.01	2.88	0.03	0.37	5.54	0.16	1.27	1.30	0.14	0.26	13.68
	6	0.39	0.16	0.21	0.22	0.30	0.26	0.03	0.01	1.95	0.03	0.13	4.50	0.06	0.70	0.98	0.09	0.21	10.20
	7	0.19	0.08	0.06	0.15	0.15	0.09	0.01	0.00	1.03	0.01	0.08	1.40	0.04	0.32	0.50	0.04	0.07	4.25
	8	0.51	0.22	0.17	0.28	0.41	0.26	0.05	0.01	2.67	0.03	0.20	6.63	0.10	0.99	1.30	0.14	0.31	14.29
	9	0.33	0.13	0.05	0.12	0.25	0.12	0.02	0.00	1.66	0.02	0.09	3.59	0.05	0.44	0.84	0.08	0.17	7.94
El Centro	10	0.15	0.06	0.13	0.16	0.11	0.13	0.01	0.00	0.75	0.01	0.07	1.14	0.02	0.41	0.38	0.06	0.06	3.65
	11	0.46	0.19	0.02	0.20	0.35	0.14	0.03	0.01	2.35	0.02	0.19	4.51	0.08	0.68	1.16	0.07	0.21	10.67
	12	0.22	0.09	0.03	0.14	0.18	0.08	0.02	0.00	1.09	0.01	0.07	2.09	0.03	0.32	0.55	0.04	0.10	5.07
	13	0.52	0.23	0.07	0.30	0.43	0.19	0.05	0.01	2.84	0.03	0.37	6.68	0.15	1.45	1.32	0.16	0.31	15.09
	14	0.25	0.11	0.02	0.32	0.23	0.08	0.03	0.00	1.31	0.02	0.32	3.27	0.06	1.18	0.64	0.12	0.17	8.13
	15	0.65	0.27	0.08	0.25	0.53	0.22	0.06	0.01	3.33	0.04	0.18	8.31	0.10	0.86	1.66	0.10	0.38	17.04
	16	0.89	0.37	0.03	0.29	0.69	0.26	0.07	0.01	4.47	0.05	0.31	10.63	0.13	1.29	2.25	0.16	0.49	22.40
	17	0.19	0.08	0.03	0.10	0.15	0.07	0.01	0.00	0.97	0.01	0.06	1.90	0.03	0.30	0.49	0.05	0.10	4.56
	18	0.27	0.11	0.05	0.12	0.21	0.10	0.02	0.00	1.35	0.01	0.08	2.88	0.04	0.36	0.68	0.04	0.14	6.45
Calexico	19	0.26	0.11	0.04	0.07	0.20	0.10	0.04	0.00	1.38	0.02	0.09	5.42	0.08	0.45	0.67	0.05	0.23	9.21
	20	0.40	0.18	0.03	0.41	0.34	0.12	0.04	0.01	2.45	0.03	0.35	5.86	0.12	1.48	1.03	0.35	0.27	13.49
	21	0.22	0.09	0.01	0.07	0.17	0.06	0.02	0.00	1.10	0.01	0.08	2.83	0.04	0.36	0.55	0.04	0.13	5.78
	22	0.30	0.12	0.13	0.15	0.23	0.17	0.03	0.00	1.57	0.02	0.11	4.54	0.07	0.58	0.76	0.07	0.20	9.09
	23	0.56	0.24	0.09	0.25	0.45	0.22	0.05	0.01	2.90	0.03	0.23	6.83	0.10	0.93	1.42	0.10	0.31	14.72
	24	0.14	0.05	0.06	0.11	0.11	0.08	0.01	0.00	0.69	0.01	0.05	1.08	0.02	0.24	0.35	0.03	0.06	3.09
Sum of cells	Brawley	4.14	1.76	0.89	1.79	3.23	1.77	0.33	0.06	22.15	0.26	1.72	48.91	0.96	7.30	10.53	0.91	2.25	108.99
	El Centro	3.59	1.50	0.46	1.87	2.90	1.27	0.31	0.06	18.46	0.21	1.66	41.42	0.64	6.84	9.13	0.80	1.94	93.06
	Calexico	1.88	0.79	0.35	1.06	1.51	0.75	0.19	0.03	10.10	0.13	0.91	26.57	0.44	4.04	4.78	0.64	1.22	55.39

At the bottom of Table B-2, the species-specific annual average hourly emission rates by grid cell are totaled vertically over the grid cells within each community inventory domain. These domain-wide emissions by species are then summed horizontally across all PM2.5 species to produce domain-wide total PM2.5 emissions in the lower right corner of the table in units of kilograms per annual average hour per inventory domain. The domain-wide total hourly PM2.5 emissions were then divided by the areas, in units of square kilometers (km^2), of the domains to derive the emissions densities, in units of kg/hr-km^2, within each domain. The PM2.5 emission density values for each of the three domains, as shown in Table B-3, are reasonably similar in the three communities, which were expected given the similar patterns of sources surrounding each of the three monitoring stations. These last steps complete the calculation of emission densities in the areas containing sources that bear the greatest responsibility for PM2.5 ambient concentrations recorded at the community monitors, and sets up the final step in forecasting the 2012 Calexico annual average PM2.5 concentration in the absence of impacts from emissions sources lying south of the international border.

The 2012 Calexico annual average PM2.5 concentration in the absence of Mexicali sources was calculated by assuming that the relationship between domain-wide PM2.5 emissions densities and annual average PM2.5 ambient concentrations is the same in each of the three communities. The ratio of the annual average ambient concentration to the emission density for each area is shown in Table B-3.

Table B-3. Community 2012 PM2.5 Emission Densities and Annual Average Concentrations

Monitoring Station	Emission Density, kg/hr-km^2	Annual Average PM2.5, μg/m^3	Ratio of Ann. Avg. PM2.5 to Emission Density, μg/m^3 / kg/hr-km^2
Brawley	0.76	8.1	10.7
El Centro	0.65	7.5	11.5
Calexico	0.65	15.8	24.3

Because the relationship between direct PM2.5 emissions and air quality at the Calexico station is substantially different from those at Brawley and El Centro, and because the meteorology at Calexico is very similar to that of the other two communities, the difference in the annual average PM2.5 level recorded at Calexico is most likely due to impacts from Mexicali emissions sources. The annual average PM2.5 level in Calexico due exclusively to emissions from sources within Imperial County was estimated by applying the air quality-to-emissions ratios calculated for the other two communities to the emission density value derived for the Calexico domain area. These calculations and the resulting annual average PM2.5 concentration in 2012 for Calexico are shown in Table B-4.

Table B-4. Calexico 2012 PM2.5 Annual Average Estimate

Monitoring Station	Emission Density, kg/hr-km^2	Annual Average PM2.5, µg/m^3	Ratio of Ann. Avg. PM2.5 to Emission Density, µg/m^3 / kg/hr-km^2
Brawley	0.76	8.1	10.7
El Centro	0.65	7.5	11.5
Calexico	0.65	7.1	11.1 (average of Brawley and El Centro)

Thus, in the absence of impacts from Mexicali emissions sources, the 2012 annual average PM2.5 concentration in Calexico would have been 7.1 µg/m^3 instead of the 15.8 µg/m^3 value recorded.

Appendix C: Source Apportionment of PM2.5 Measured at the Calexico Monitoring Site

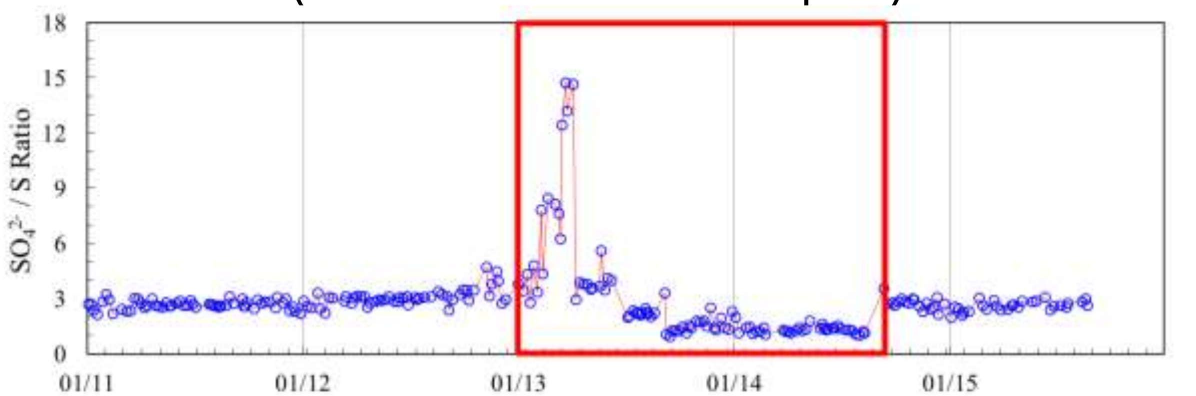
Positive matrix factorization (PMF) is a multivariate source apportionment method that deduces source profiles as well as contributions from PM2.5 speciation data. PMF is one of several U.S. EPA-recommended receptor modeling methods.[1] To identify major PM2.5 sources affecting the Calexico monitoring site, PMF was used in this analysis.

Sample Collection and Data Screening

The PM2.5 speciation samples were collected by Spiral Ambient Speciation Samplers[2] on a one-in-six day schedule at the Calexico-Ethel SLAMS (State and Local Air Monitoring Stations) network monitoring site located in Imperial County.

Since sulfate (SO_4^{2-}) and sulfur (S) are collected on different filters with different flow channels, and analyzed by different laboratory methods (Ion Chromatography and X-Ray Fluorescence, respectively), and SO_4^{2-} mass concentration already includes S in it, the SO_4^{2-}-to-S ratio has been used as an indicator of speciation data quality. Between January 2013 and August 2014 there were flow controller issues associated with the SASS sampler individual flow channels. The variable sampler flow rate resulted in the anomalous SO_4^{2-}-to-S ratios as shown in Figure C-1. Therefore PM2.5 speciation data between January 2013 and August 2014 were considered suspect and were invalidated by CARB. To make an equally weighted dataset for the analysis, speciation data collected in 2011, 2012, and between September 2014 and August 2015 were included in this analysis.

Figure C-11. Sulfate (SO_4^{2-})-to-sulfur (S) ratios between Jan. 2011 and Aug. 2015 (Red box indicates invalidation time period)



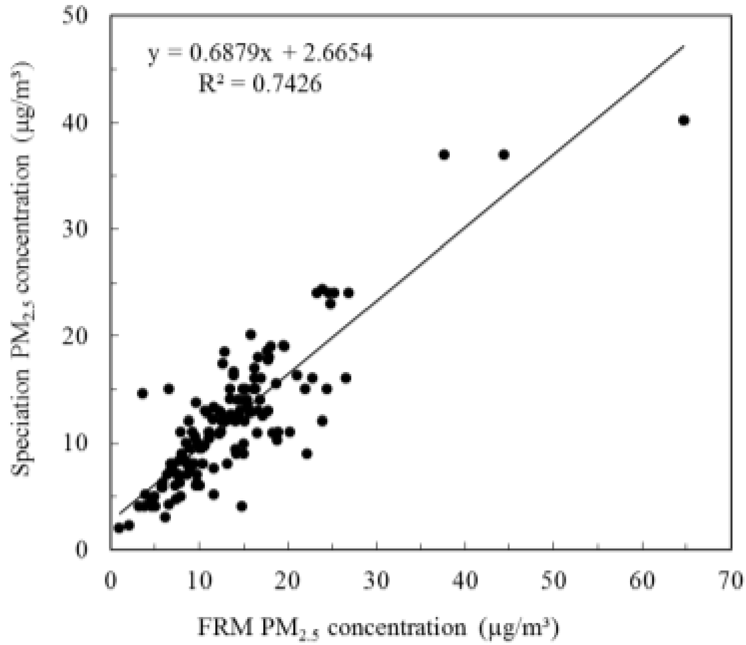
With respect to other aspects of data review, CARB staff compared PM2.5 mass data measured by the speciation sampler and the collocated Federal Reference Method (FRM) sampler at the Calexico air monitoring site (Figure C-2). Reasonable agreement

[1] US Environmental Protection Agency. EPA Positive Matrix Factorization (PMF) 3.0 Fundamentals & User Guide (EPA 600/R-08/108). Research Triangle Park, NC. July 2008. Available on Internet at http://www.epa.gov/heasd/documents/EPA_PMF_3.0_User_Guide.pdf

[2] SASS; Met One Instruments, Grants Pass, OR

between January 2011 and August 2015 was noted (*slope* = 0.69, *Intercept* = 2.67, r^2 = 0.74).

Figure C-2. FRM PM2.5 versus Speciation PM2.5 between 2011 and 2015



For the source apportionment analysis, samples were excluded from the data set for which the PM2.5, organic carbon (OC), or elemental carbon (EC) data were not available, or for which PM2.5, OC, or EC data were flagged for errors. Samples for which the sum of all measured species were larger than the PM2.5 concentrations or for which the sum of all measured species were less than 50 percent of PM2.5 concentrations were excluded. Four samples has unusually high SO_4^{2-}-to-S ratio between 3.8 and 4.7, and they were also excluded. Overall, 16.4 percent of the samples were excluded in this analysis.

For the chemical species screening, X-Ray Fluorescence (XRF) determined S was excluded from the analyses to prevent double counting of mass concentrations since XRF S and Ion Chromatography (IC) SO_4^{2-} were highly correlated (*slope* = 2.7, r^2 = 0.97). Due to the higher analytical precision compared to XRF Na and XRF K, IC Na^+ and IC K^+ were included in the analyses. Chemical species that had below minimum detection level (MDL) values more than 90 percent were excluded. The species that had Signal-to-Noise (*S/N*) ratios below 0.2 were excluded.[3] After these exclusions, a total of 148 samples and 27 species including PM2.5 mass concentrations collected between January 2011 and August 2015 were analyzed. A summary of these PM2.5 speciation data is provided in Table C-1.

[3] Paatero, P., Hopke, P.K. Discarding or downweighting high-noise variables in factor analytic models, Analytica Chimica Acta, 490, 277-289, 2003.

Table C-1. Summary of PM2.5 species mass concentrations at Calexico between 2011 and 2015

Species	Arithmetic mean (µg/m³)	Geometric mean (µg/m³)	Minimum (µg/m³)	Maximum (µg/m³)	Number of below MDL[1] values (percent)	S/N ratio[2]
PM2.5	11.7459	10.3771	2.0000	37.0000	0	NA [3]
OC	3.1986	2.6411	0.7000	14.0000	0	NA
EC	0.7983	0.5894	0.0500	2.8000	3.4	235.8
SO_4^{2-}	1.1971	1.0198	0.2060	4.7000	0	NA
NO_3^-	1.1466	0.8255	0.1400	6.0600	0	NA
NH_4^+	0.5253	0.3836	0.0250	2.3800	4.7	221.6
Al	0.1497	0.0947	0.0075	0.6700	8.8	105.1
Ba	0.0158	0.0136	0.0100	0.0510	63.5	0.7
Br	0.0112	0.0073	0.0010	0.0710	8.1	68.3
Ca	0.2235	0.1790	0.0300	0.9200	0	NA
Cl	0.2162	0.1016	0.0070	2.2000	0	NA
Co	0.0026	0.0021	0.0015	0.0110	66.9	0.8
Cr	0.0022	0.0017	0.0015	0.0370	86.5	0.3
Cu	0.0140	0.0101	0.0020	0.0670	8.8	39.2
Fe	0.1954	0.1590	0.0140	0.5800	0	NA
K^+	0.1371	0.0974	0.0650	0.9730	70.9	1.0
Mn	0.0064	0.0044	0.0015	0.0320	24.3	8.3
Na^+	0.2202	0.1571	0.0400	0.9240	19.6	13.5
Ni	0.0024	0.0020	0.0015	0.0200	89.9	0.2
Pb	0.0135	0.0068	0.0015	0.1100	22.3	19.7
P	0.0053	0.0038	0.0020	0.0260	56.1	1.9
Sb	0.0139	0.0122	0.0100	0.0720	81.8	0.4
Se	0.0030	0.0014	0.0010	0.0330	79.1	1.4
Si	0.5093	0.3995	0.0230	2.0000	0	NA
Sr	0.0028	0.0022	0.0015	0.0090	54.1	1.3
Ti	0.0138	0.0114	0.0020	0.0480	4.1	84.6
Zn	0.0942	0.0284	0.0010	1.0000	0.7	6972.0

[1] Minimum detection level
[2] Signal-to-noise ratio[4]
[3] Not Available (infinite S/N ratio caused by no below average MDL value)

[4] Paatero, P., Hopke, P.K. Discarding or downweighting high-noise variables in factor analytic models, Analytica Chimica Acta, 490, 277-289, 2003.

The application of PMF depends on the estimated uncertainties which are based on the analytical uncertainties for each of the measured data. Since the SLAMS data were not accompanied by analytical uncertainties, the fractional uncertainties suggested for PMF analysis by Kim et al (2005)[5] were used (Table C-2).

Table C-2. Estimated fractional uncertainties for SLAMS data at Calexico

Species	Fractional uncertainty	Species	Fractional uncertainty
OC	0.07	Fe	0.05
EC	0.07	K^+	0.07
SO4	0.07	Mn	0.05
NO_3^-	0.07	Na^+	0.07
NH_4^+	0.07	Ni	0.05
Al	0.10	Pb	0.05
Ba	0.05	P	0.10
Br	0.05	Sb	0.05
Ca	0.11	Se	0.05
Cl	0.10	Si	0.10
Co	0.10	Sr	0.05
Cr	0.05	Ti	0.05
Cu	0.05	Zn	0.05

To assign input data for PMF, the procedure of Polissar et al. (1998)[6] was used. The measurement values were used for the input concentration data, and the sum of the analytical uncertainty and one-third of the detection limit value was used as the input uncertainty assigned to each measured value. Concentration values below detection limits were replaced by one half of the detection limit values, and their input uncertainties were set at five-sixths of the detection limit values. Missing values were replaced by the geometric mean of the measured values for each species, and to down-weight these replaced data and then to reduce their influence on the solution, their accompanying uncertainties were set at four times the geometric mean value.

To estimate the potential directions of the local sources impacting the Calexico monitor, the conditional probability function (CPF)[7] was calculated for each source using the source contribution estimates from PMF coupled with the wind data. The same 24-hour averaged contribution was assigned to each hour of a given day to match to the hourly

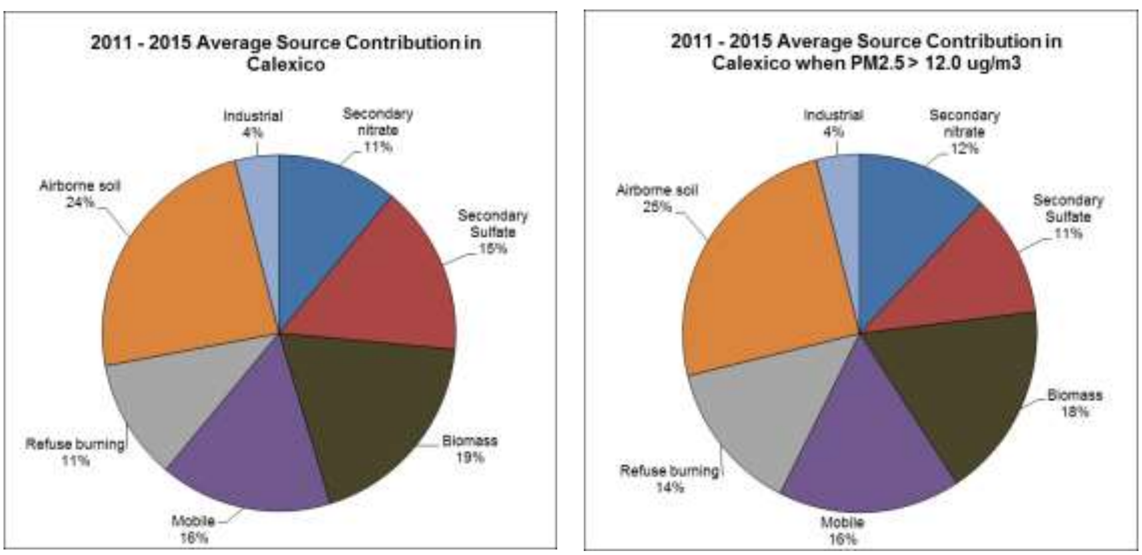
[5] Kim, E., Hopke, P.K. and Qin, Y. Estimation of organic carbon blank values and error structures of the speciation trends network data for source apportionments, Journal of Air and Waste Management Association 55, 1190–1199, 2005.
[6] Polissar, A.V., Hopke, P.K., Paatero, P., Malm, W.C. and Sisler, J.F. Atmospheric Aerosol over Alaska 2. Elemental Composition and Sources, Journal of Geophysical Research, 103, 19045-19057, 1998.
[7] Kim, E., Hopke, P.K. Comparison between conditional probability function and nonparametric regression for fine particle source directions, Atmospheric Environment 38, 11, 4667-4673, 2004.

wind data. For each source category, the CPF estimates the probability of emission transport from each wind direction. The predominant emissions for source categories are likely to be located in directions that have high CPF values. In this analysis, from tests with several values of percentiles of the contribution and different azimuths of wind sectors, the upper 25 percent of source contributions and 24 compass arcs of 15 degrees each were chosen. And the probability of emission transport was estimated for each compass arc independently. Calm winds (< 1 m/sec) were excluded from this analysis due to the isotropic behavior of wind vanes under calm conditions.

Results and Discussions

A seven-source model without matrix rotation (rotational parameter FPEAK = 0) provided the most physically interpretable source profiles for the Calexico site. To down-weight the variable in the analysis so that the noise does not compromise the solution, it was found necessary to increase the input uncertainty of Na^+ by a factor of 3 to obtain physically interpretable PMF results[8],. Figure C-3 and Table C-3 present average source contributions in Calexico between January 2011 and August 2015. The pie charts in Figure C-3 show that the average source contribution of refuse burning increased the most on high (> 12.0 $\mu g/m^3$) PM2.5 days at Calexico compared to all days combined. Figure C-4 shows monthly average source contributions.

Figure C-3. Average source contributions between 2011 and 2015

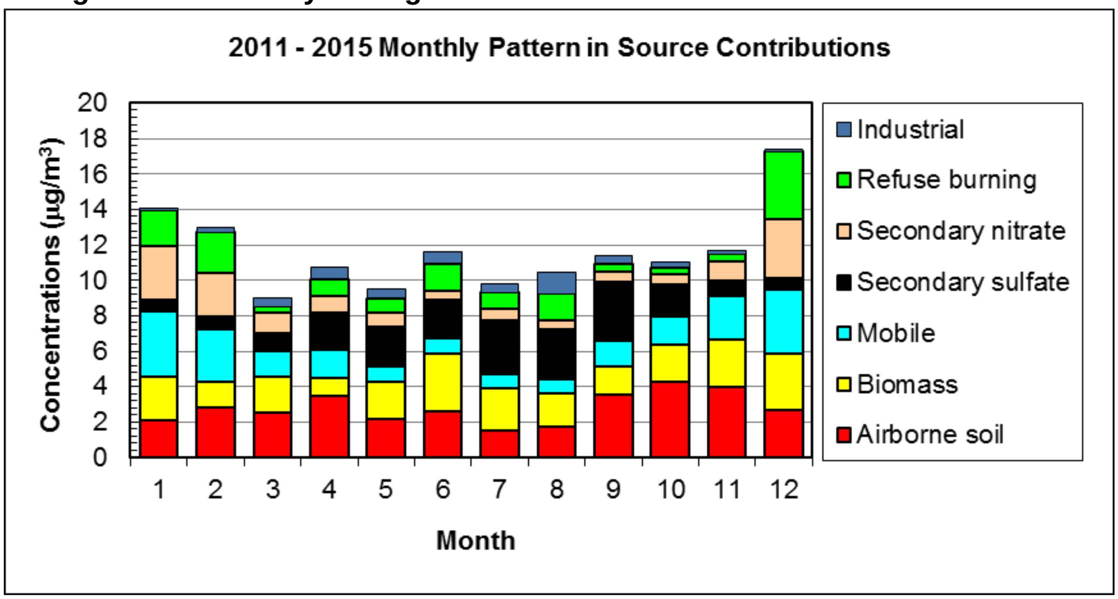


[8] Paatero, P., Hopke, P.K. Discarding or downweighting high-noise variables in factor analytic models, Analytica Chimica Acta, 490, 277-289, 2003.

Table C-3. Average source contributions (µg/m³) to PM2.5 mass concentration between January 2011 and August 2015

Sources	Average source contribution (± 95 percent distribution)
Airborne soil	2.78 (0.39)
Biomass burning	2.19 (0.29)
Mobile	1.83 (0.28)
Secondary sulfate	1.79 (0.22)
Secondary nitrate	1.28 (0.29)
Refuse burning	1.28 (0.37)
Industrial	0.47 (0.14)
Estimated PM2.5 (µg/m³)	11.61 (0.95)
Measured PM2.5 (µg/m³)	11.75 (0.93)

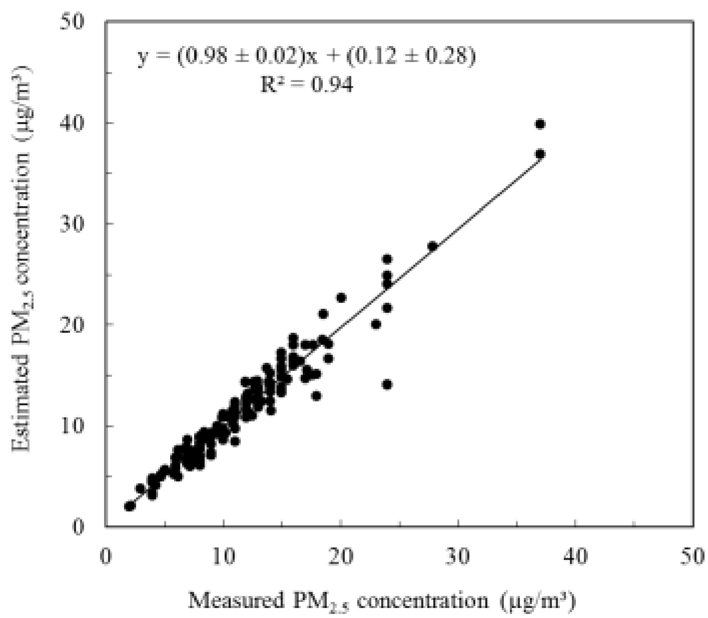
Figure C-4. Monthly average source contributions between 2011 and 2015



Comparisons of the reconstructed PM2.5 mass contributions (sum of contributions from seven sources) with measured PM2.5 mass concentrations in Figure C-5 shows that the resolved sources effectively reproduce the measured values and account for most of the variation in the PM2.5 mass concentrations (*slope* = 0.98, r^2 = 0.94). The source profiles, corresponding source contributions, monthly variations of source contributions, weekday/weekend variations, and potential source directions are presented in Figures C-6 through C-10, presented at the end of this Appendix.

Airborne soil has high concentrations of Si, Fe, Al and Ca. This source category contributed the most, accounting for 23.9 percent of the PM2.5 mass concentration at Calexico. The airborne soil category includes wind-blown dust as well as re-suspended crustal materials by road traffic as indicated by the presence of OC and EC in the source profile in Figure C-6. Airborne soil contributions at Calexico peaked in the spring and fall (Figure C-8) and were higher on weekdays than weekends (Figure C-9). The CPF plot for airborne soil points southeast, south, and southwest suggesting significant source contributions from the Mexicali area (Figure C-10).

Figure C-5. Measured versus PMF predicted PM2.5 mass concentrations



Biomass burning contributed 18.8 percent of the PM2.5 concentration at Calexico. Biomass burning was characterized by OC, EC, and K^+.[9] This category includes PM2.5 contributions from field burning, residential wood burning, and cooking. Biomass burning shows June and December high trends suggesting that it was mostly contributed by field burning and winter heating. Biomass burning at the Calexico monitor does not show weekend/weekday contribution trends. The CPF plot for biomass burning at Calexico suggests higher contributions from the northeast in addition to the Mexicali area.

Mobile source was identified by high concentrations of OC and EC, and minor species such as Fe.[10] It also includes soil dust constituents (Si, Ca) indicating that some re-suspended road dusts by vehicle traffic are not separable because of the same temporal variation. The ratio of OC/EC for this source, 2.55, is similar to 2.65 (Imperial County) and 2.73 (Mexicali) in motor vehicle PM2.5 emissions reported in an earlier

[9] Watson, J.G., Chow, J.C., Houck, J.E., PM2.5 chemical source profiles for vehicle exhaust, vegetative burning, geological material, and coal burning in northwestern Colorado during 1995, Chemosphere, 43, 1141–1151, 2001.
[10] Watson, J.G., Chow, J.C., Lowenthal, D.H., Pritchett, L.C. and Frazier, C.A. Differences in the carbon composition of source profiles for diesel and gasoline powered vehicles, Atmospheric Environment 28(15), 2493-2505, 1994.

study.[11] The average contribution from mobile sources to the PM2.5 mass concentration was 15.8 percent at Calexico. Mobile source shows a winter-high seasonal trend and shows weak weekday high variation. The CPF plot for the mobile source category at Calexico-Ethel also suggests high contributions from the nearby U.S./Mexico border crossing area.

Secondary sulfate is identified by its high concentrations of SO_4^{2-} and NH_4^+. It consists of $(NH_4)_2SO_4$ and several minor species such as secondary OC, Na^+, K^+, and Si that transport together. It contributed 15.4 percent of the PM2.5 mass concentration. Secondary sulfate shows strong seasonal variation with higher concentrations in summer when photochemical activity is high. Secondary sulfate does not show weekday/weekend variation. The CPF plot points south and southeast indicating a strong influence from sources in the Mexicali area. Na^+ in secondary sulfate indicates that the secondary sulfate source also includes aged sea salt that reflects particles in which Cl^- in the fresh sea salt is partially displaced by acidic gases during transport and collected along with SO_4^{2-}.[12] K^+ and Si in the source profile seem to reflect contributions from field burning smoke and re-suspended soil from the surrounding agricultural area, respectively. These contributions were not separated from secondary sulfate because they originated from similar directions and had similar summer-high temporal behavior.

Secondary nitrate has high concentrations of NO_3^- and NH_4^+ and accounted for 11 percent of the PM2.5 mass concentration at Calexico. Secondary nitrate has a winter-high trend with the highest concentrations found in December and January and shows weak weekday high variation. It has strong source directionality to the southwest suggesting high contributions from the U.S./Mexico border crossing area.

Refuse burning is characterized by OC, Cl, and K^+.[13] The refuse burning smoke category reflects contributions from burning of garbage and other waste materials including wood products. The high Cl concentration in this source likely derives from the burning of tires and polyvinyl chloride in garbage. Higher contributions from refuse burning in winter indicate the impacts from bonfires that are part of Mexicali festival and holiday traditions in December, including a sharp peak on December 11, 2011. This source category contributed 11 percent to the PM2.5 mass concentration at Calexico. Refuse burning impacts did not exhibit any weekday/weekend variation. As shown in Figure C-10, major sources of refuse burning were located to the south of the Calexico monitor.

Industrial sources are characterized by high concentrations of EC, SO_4^{2-}, NO_3^-, Cl, Fe, Na^+, Pb, Si, and Zn. Potential industrial sources include metal processing, fly ash/emissions from brick kilns, cement kilns, and various incinerators. This source

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[11] Watson, J.G., and Chow, J.C., Source characterization of major emission sources in the Imperial and Mexicali Valleys along the US/Mexico border, The Science of the Total Environment, 276, 33-47, 2001.
[12] Song, C.H., Carmichael, G.R. The aging process of naturally emitted aerosol (sea salt and mineral aerosol) during long-range transport, Atmospheric Environment 33, 2203-2218, 1999.
[13] Christian, T. J., Yokelson, R. J., C´ardenas, B., Molina, L. T., Engling, G., Hsu, S.-C., Trace gas and particle emissions from domestic and industrial biofuel use and garbage burning in central Mexico, Atmos. Chem. Phys., 10, 565–584, 2010.

category accounts for 4 percent of the PM2.5 mass concentrations and it shows a summer-high trend and has weekend high variations. The CPF plot for the industrial source category shows high contributions from the south and southeast.

3. Conclusions

PM2.5 speciation data and related meteorological data collected at the Calexico monitoring site between January 2011 and August 2015 were analyzed for source apportionment. Using PMF, the multivariate source apportionment tool, seven major PM2.5 source categories were identified: airborne soil, biomass burning, mobile, secondary sulfate, secondary nitrate, refuse burning, and industrial sources. Approximately 15 percent of the PM2.5 in Calexico was contributed by sources that are not found on the U.S. side of the border in Imperial County (i.e., refuse burning and industrial sources). Also, the source directionality analyses show that most of the PM2.5 from mobile and secondary nitrate sources (~27 percent of total PM2.5 mass concentration at the Calexico monitor) originated from the U.S.-Mexico border crossing area.

Figure C-6. Source profiles deduced from PM2.5 samples collected at Calexico (prediction ± standard deviation)

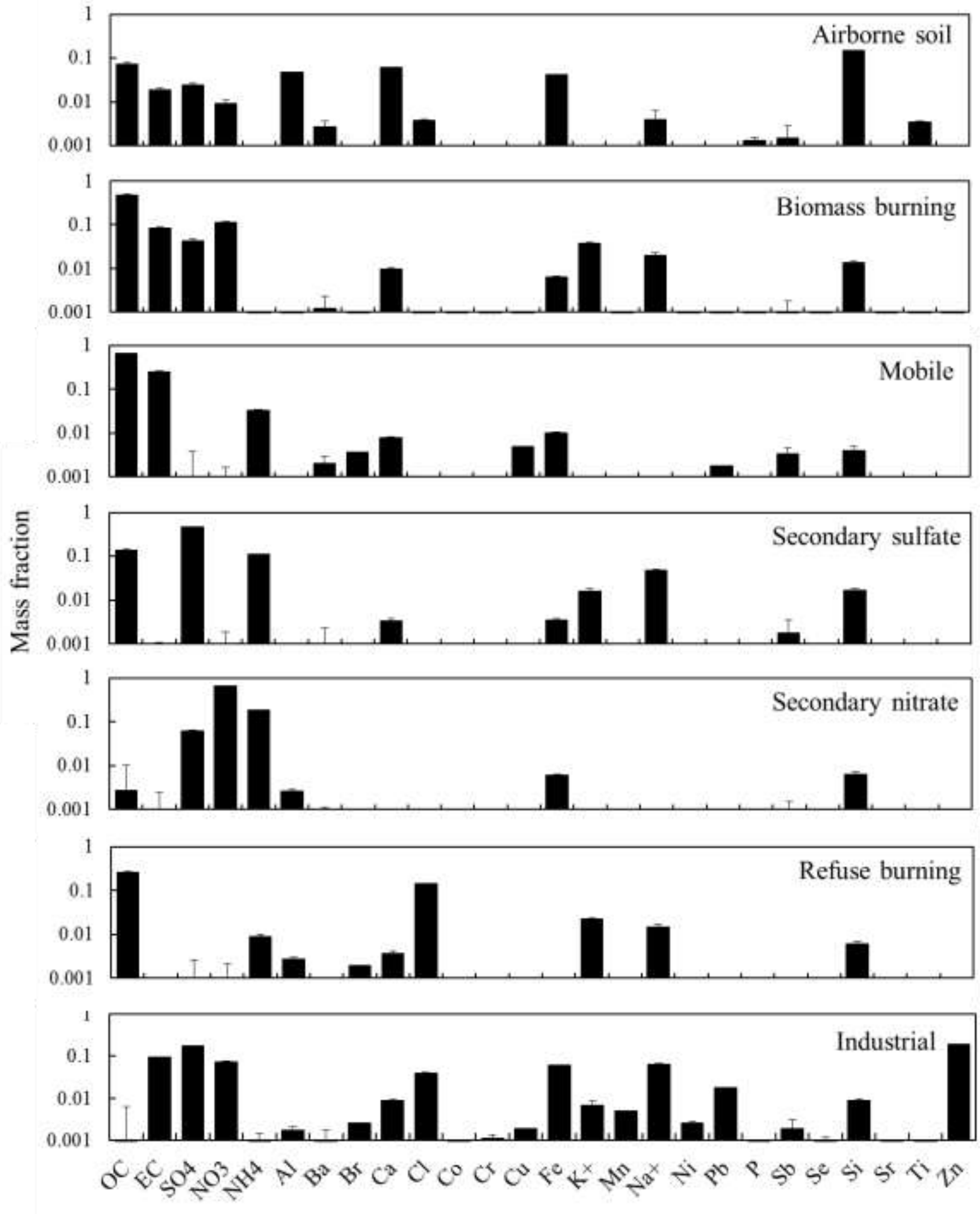


Figure C-7. Source contributions deduced from PM2.5 samples collected at Calexico

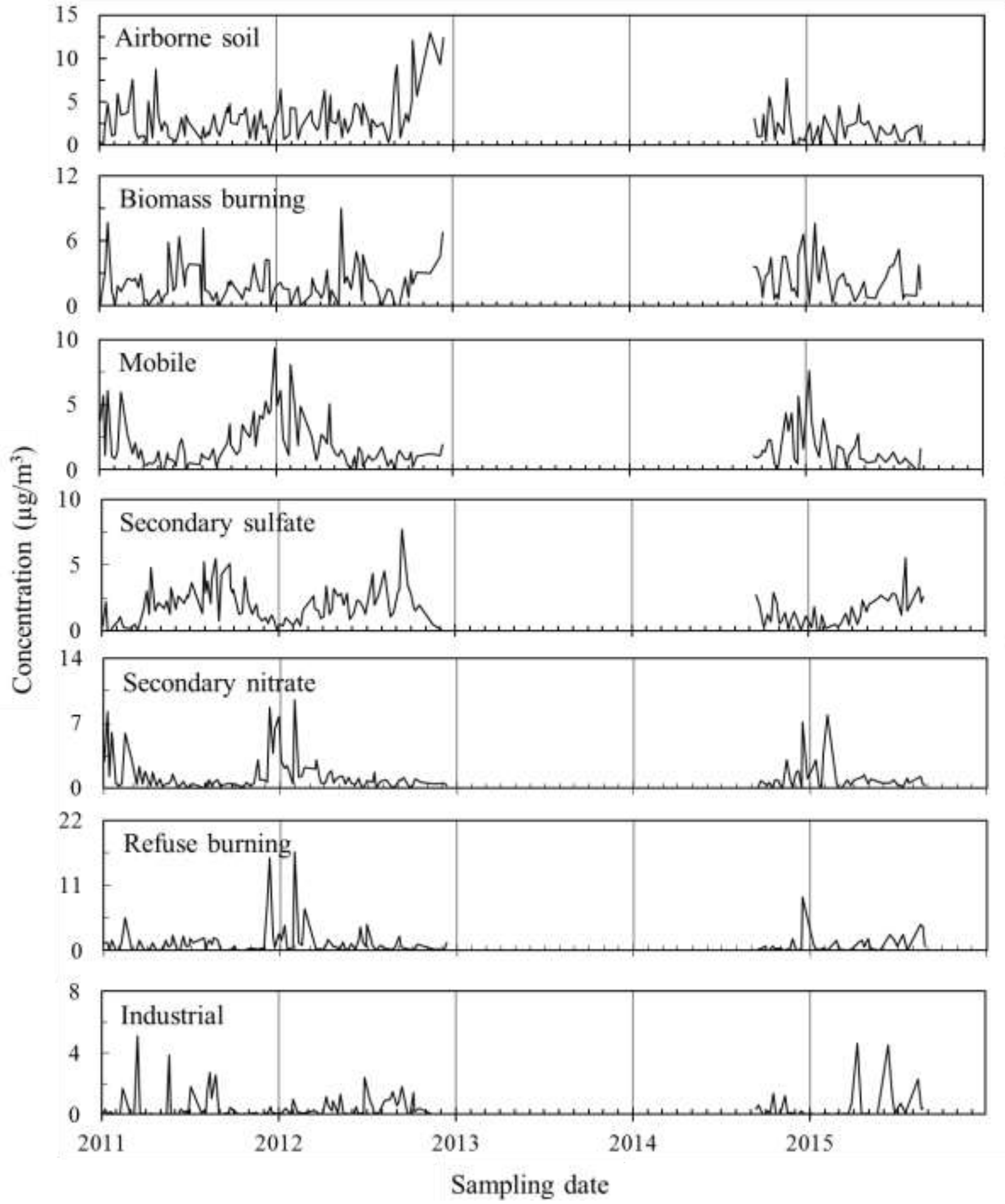


Figure C-8. Monthly variations of source contributions to PM2.5 mass concentrations at Calexico (mean ± 95 percent distribution)

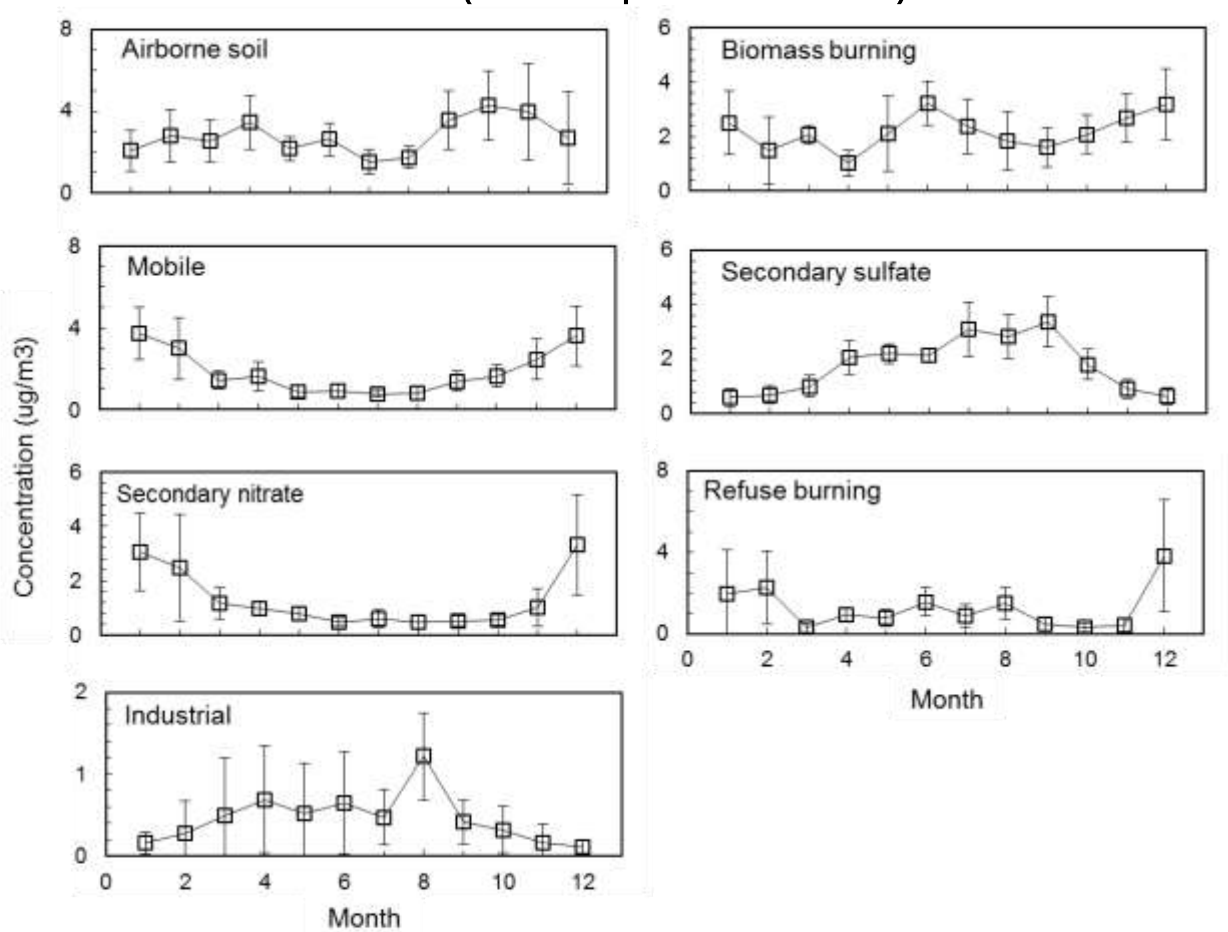


Figure C-92. Weekday/weekend variations of source contributions to PM2.5 mass concentrations at Calexico. (Mean ± 95 percent distribution)

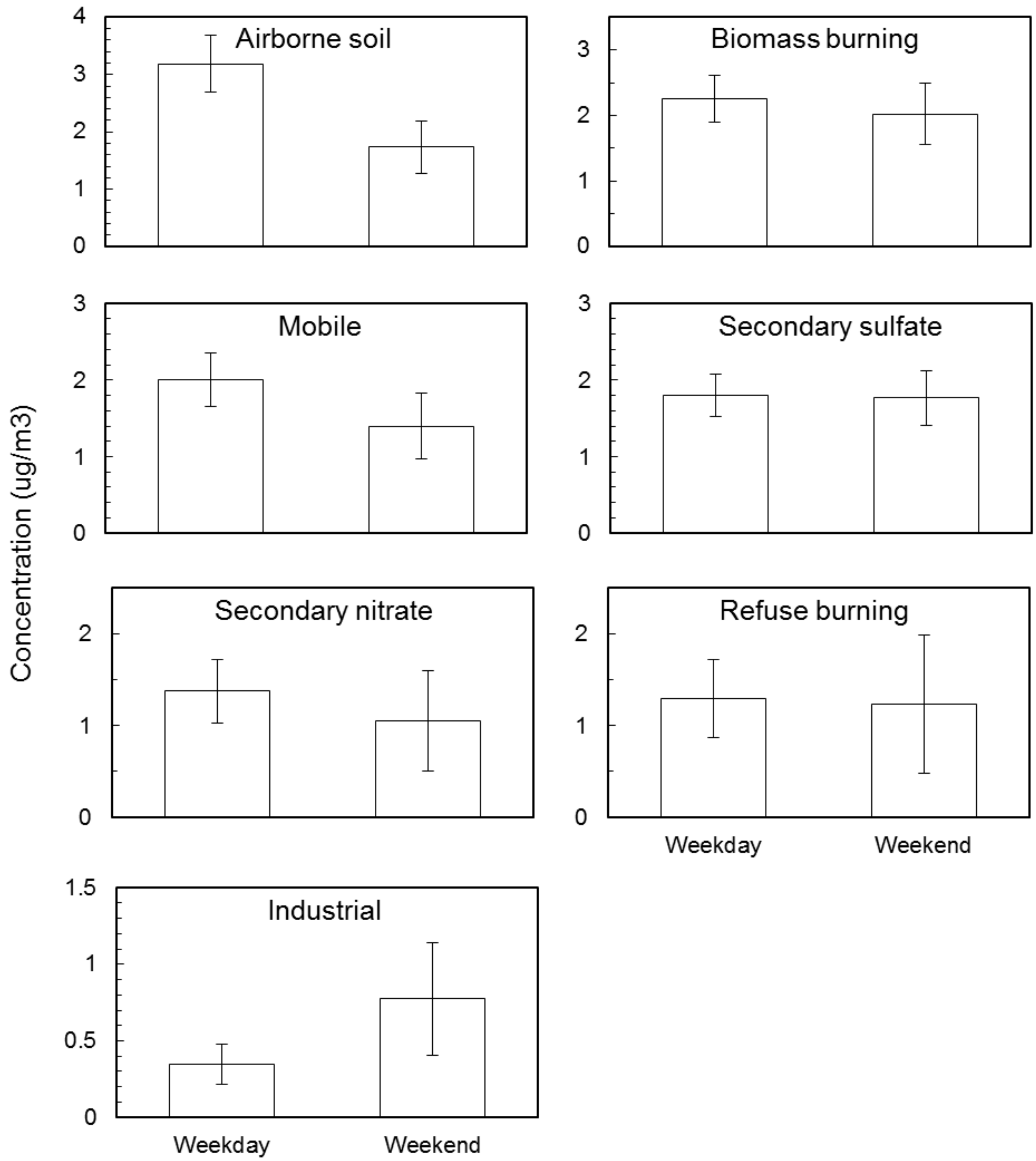
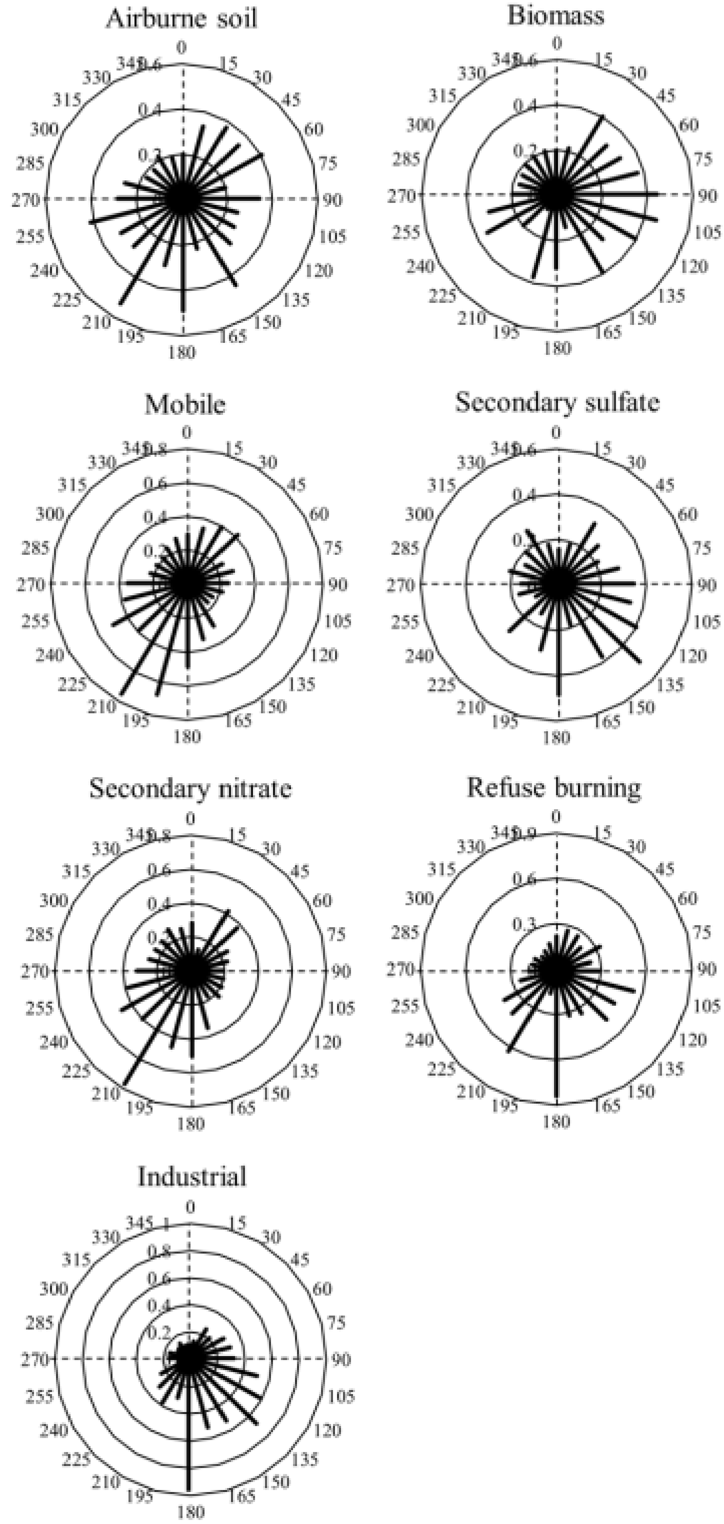


Figure C-10. Conditional probability function plots for the highest 25 percent of the source contributions



APPENDIX D: MODELING ASSESSMENT

Photochemical Modeling for the 2017 Imperial County Annual $PM_{2.5}$ State Implementation Plan

Prepared by
California Air Resources Board
Imperial County Air Pollution Control District

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ACRONYMS

ACM – Asymmetric Convective Model
AQMD – Air Quality Management District
AQS – Air Quality System
BCs – Boundary Conditions
CalNex – California Nexus
CARB – California Air Resources Board
CARES – Carbonaceous Aerosols and Radiative Effects Study
CMAQ Model – Community Multi-scale Air Quality Model
DISCOVER-AQ – Deriving Information on Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality
DV – Design Value
E-AIM – Extended Aerosol Inorganics Model
EBI – Euler Backward Iterative
EC – Elemental Carbon
FEM – Federal Equivalent Method
FRM – Federal Reference Method
GEOS-5 – Goddard Earth Observing System Model, Version 5
GMAO – Global Modeling and Assimilation Office
ICs – Initial Conditions
IOA – Index of Agreement
MB – Mean Bias
ME – Mean Error
MEGAN – Model of Emissions of Gases and Aerosols from Nature
MFB – Mean Fractional Bias
MFE – Mean Fractional Error
MOZART – Model for Ozone and Related chemical Tracers
NARR – North American Regional Reanalysis
NASA – National Aeronautics and Space Administration
NCR – National Center for Atmospheric Research
NH_3 – Ammonia
NMB – Normalized Mean Bias
NME – Normalized Mean Error
NO_x – Oxides of Nitrogen
OC – Organic Carbon
OM – Organic Matter
PBL – Planetary Boundary Layer
$PM_{2.5}$ – Particulate Matter of Aerodynamic Diameter less than 2.5 micrometers
RH – Relative Humidity

RMSE – Root Mean Square Error
ROG – Reactive Organic Gases
RRF – Relative Response Factors
SANWICH – Sulfate, Adjusted Nitrate, Derived Water, Inferred Carbon Hybrid material balance
SAPRC – Statewide Air Pollution Research Center
SCAQMD – South Coast Air Quality Management District
SIP – State Implementation Plan
SJV – San Joaquin Valley
SLAMS – State and Local Air Monitoring Stations
SOA – Secondary Organic Aerosol
SO_x – Sulfur oxides
U.S. EPA – United States Environmental Protection Agency
VOCs – Volatile Organic Compounds
WRF – Weather and Research Forecasting
YSU – Yon-Sei University

INTRODUCTION

The purpose of this document is to summarize the findings of the modeling assessment for the annual $PM_{2.5}$ (12 µg/m^3) standard in the Imperial County nonattainment area (Imperial or the County), which informs the scientific basis for the Imperial County 2017 Annual $PM_{2.5}$ SIP. The 12 µg/m^3 standard was promulgated by the U.S. EPA in 2012, and EPA issued final designations in 2014. Currently, the County is designated as a moderate nonattainment area for this standard, with an attainment date of 2021.

Findings from the model attainment demonstration are summarized for each of the three $PM_{2.5}$ monitoring sites within the non-attainment area. Due to the close proximity of Imperial County to the Mexico border and the city of Mexicali, it is routinely impacted by cross-border emission sources, which have an adverse effect on the County's air quality. This is particularly true for the design site in Calexico, which defines attainment for the region, and is located just north of the U.S.-Mexico border. Given the close proximity to Mexico emission sources, the modeling assessment will also investigate the influence that emissions from Mexico have on $PM_{2.5}$ levels in Imperial County. The remainder of the document is organized as follows: Section 2 describes the general approach utilized in the model attainment demonstration, Section 3 discusses the meteorological modeling and evaluation, while Sections 4 and 5 describe the emissions inventory and $PM_{2.5}$ modeling and evaluation, respectively. A more detailed description of the modeling and development of the model-ready emissions inventory can be found in the Photochemical Modeling Protocol and Modeling Emissions Inventory Appendices.

1 APPROACH

This section briefly describes the California Air Resources Board's (CARB's) procedures, based on U.S. EPA guidance (U.S. EPA, 2014), for projecting annual $PM_{2.5}$ Design Values (DVs) to the future using model output and a Relative Response Factor (RRF) approach in order to show future year 2021 attainment of the 12 µg/m^3 annual $PM_{2.5}$ standard, as well as assessing the impact of cross border emissions from Mexico on $PM_{2.5}$ levels in Imperial County.

1.1 METHODOLOGY

The U.S. EPA modeling guidance (U.S. EPA, 2014) outlines the approach for using models to predict future year annual $PM_{2.5}$ DVs. The guidance recommends using model predictions in a "relative" rather than "absolute" sense. In this relative approach, the fractional change (or ratio) in $PM_{2.5}$ concentration between the model future year and model baseline year are calculated for all valid monitors. These ratios are called relative response factors (RRFs). Since $PM_{2.5}$ is comprised of different chemical species, which respond differently to changes in emissions of various pollutants, separate RRFs are calculated for the individual $PM_{2.5}$ species. Baseline DVs are then projected to the future on a species-by-species basis, where the DV is separated into individual $PM_{2.5}$ species and each species is multiplied by its corresponding RRF. The individual species are then summed to obtain the future year $PM_{2.5}$ DV.

A brief summary of the modeling procedures utilized in this attainment analysis, as prescribed by the U.S. EPA modeling guidance (U.S. EPA, 2014), is provided below. A more detailed description can be found in the Photochemical Modeling Protocol Appendix.

1.2 MODELING PERIOD

The year 2012 was chosen for baseline modeling in order to utilize the most recent and up to date emissions inventory available (http://www.arb.ca.gov/planning/sip/2012iv/2012iv.htm) and to maintain consistency with the South Coast AQMD 2016 Air Quality Management Plan (http://www.aqmd.gov/home/library/clean-air-plans/air-quality-mgt-plan/Draft2016AQMP), which utilizes the same baseline year inventory.

1.3 BASELINE DESIGN VALUES

Specifying the baseline DV is a key consideration in the model attainment test, because this value is projected forward to the future and then used to test for future attainment of the standard at each monitor. U.S. EPA guidance (2014) defines the annual $PM_{2.5}$ DV for a given year as the 3-year average (ending in that year) of the annual average $PM_{2.5}$ concentrations, where the annual average is calculated as the average of the quarterly averages for each calendar quarter (e.g., January-March, April-June, July-September, October-December). For example, the 2012 $PM_{2.5}$ DV is the average of the annual $PM_{2.5}$ concentrations from 2010, 2011, and 2012.

To minimize the influence of year-to-year variability in demonstrating attainment, the U.S. EPA (2014) optionally allows the averaging of three DVs, where one of the years is the baseline emissions inventory and modeling year. This average DV is referred to as the baseline DV. For a baseline modeling year of 2012, this means that the average of the 2012, 2013, and 2014 DVs are typically used. Since each DV represents an average over three years, observational data from 2010, 2011, 2012, 2013, and 2014 will influence the baseline DV, with each year receiving a different weighting. Table 1 illustrates the observational data from each year that goes into the baseline DV calculation. Table 2 shows the 2012-2014 average DVs (or baseline DVs) for each Federal Reference Method (FRM) monitor in Imperial County. The highest DV occurred at the Calexico-Ethel Street monitor, which had a baseline DV of 14.2 $\mu g/m^3$.

Table 1. Illustrates the data from each year that were utilized in the baseline DV calculation.

DV Year	Years averaged for the DV (average of quarterly average $PM_{2.5}$)				
2012	2010	2011	2012		
2013		2011	2012	2013	
2014			2012	2013	2014

Table 2. Average baseline DVs for each FRM monitoring site in Imperial County, as well as the yearly DVs from 2012-2014 utilized in calculating the baseline DVs.

AQS site ID	Monitoring Site Name	2012	2013	2014	2012-2014 Average Baseline
060250005	Calexico-Ethel St	14.1	14.3	14.3	14.2
060251003	El Centro	7.2	7.3	7.0	7.2
060250007	Brawley	7.2	7.5	7.5	7.4

1.4 BASELINE AND SENSITIVITY SIMULATIONS

The modeling assessment consists of the following four primary model simulations, which utilize the same model inputs for meteorology, chemical boundary conditions, and biogenic emissions. Simulations only differ with regards to the California and Mexico anthropogenic emissions inventories utilized.

1. *Base Year (or Base Case) Year Simulation*
   The base year simulation for 2012 was used to assess model performance and includes as much day-specific detail as possible in the emissions inventory, such as hourly adjustments to the motor vehicle and biogenic inventories based on observed local meteorological conditions, as well as known wildfire and agricultural burning events.

2. *Reference (or Baseline) Simulation*
   The reference year simulation was identical to the base year simulation, except that certain emissions events which are either random and/or cannot be projected to the future were removed from the emissions inventory. For the 2012 reference year modeling, wildfires were excluded due to the difficulty in predicting future fires and since they can influence the model response to anthropogenic emissions reductions in regions and times when large fires occur.

3. *Future Year Simulation*
   The future year simulation is identical to the reference year simulation, except that projected future year (2021) anthropogenic emission levels for both California and Mexico were used rather than the 2012 emission levels. All other model inputs (e.g., meteorology, chemical boundary conditions, biogenic emissions, and calendar for day-of-week specifications in the inventory) are the same as those used in the reference year simulation.

4. *Future Year Sensitivity Simulation with Mexico Anthropogenic Emissions Excluded (Zero out)*
   To investigate the impacts of Mexico anthropogenic emissions on future year DVs, a future year sensitivity simulation was conducted, which followed the same approach as the Future Year Simulation (3) above, but where future year (2021) Mexico anthropogenic emissions were set to zero for all species. Note that the chemical boundary conditions along the southern border still reflect the influence of Mexico emissions outside of the modeling domain.

To summarize (Table 3), the base year 2012 simulation was used for evaluating model performance, while the reference (or baseline) 2012 and future year 2021 (including the sensitivity simulation) were used to project the average DVs to the future year as described in the Photochemical Modeling Protocol Appendix and in subsequent sections of this document.

Table 3. Description of CMAQ model simulations used to evaluate model performance and project baseline DVs to the future.

Simulation	Anthropogenic Emissions	Biogenic Emissions	Meteorology	Chemical Boundary Conditions
Base year (2012)	2012 w/ wildfires w/ Mexico	2012 MEGAN	2012 WRF	2012 MOZART
Reference year (2012)	2012 w/o wildfires w/ Mexico	2012 MEGAN	2012 WRF	2012 MOZART
Future year (2021)	2021 w/o wildfires w/ Mexico	2012 MEGAN	2012 WRF	2012 MOZART
Future year sensitivity (2021)	2021 w/o wildfires w/o Mexico	2012 MEGAN	2012 WRF	2012 MOZART

1.5 $PM_{2.5}$ SPECIES CALCULATIONS

Since $PM_{2.5}$ consists of different chemical components, it is necessary to assess how each individual component will respond to emission reductions. As a first step in this process, the measured total $PM_{2.5}$ must be separated into its various components. In the Imperial Valley, the primary components on the filter based $PM_{2.5}$ measurements include sulfates, nitrates, ammonium, organic carbon (OC), elemental carbon (EC), particle-bound water, other primary inorganic particulate matter, and passively collected mass (blank mass). Species concentrations were obtained from the Calexico speciation monitor, where measurements were made once every six days. Since Calexico is the only speciation monitor in the County, those measurements were used to represent the speciation profile at all three FRM monitors.

Table 4. $PM_{2.5}$ speciation data used for each $PM_{2.5}$ design site.

AQS Site ID	$PM_{2.5}$ Design Site (FRM Monitor)	$PM_{2.5}$ Speciation Site
060250005	Calexico-Ethel St	Calexico-Ethel St
060251003	El Centro	Calexico-Ethel St
060250007	Brawley	Calexico-Ethel St

Since the FRM $PM_{2.5}$ monitors do not retain all of the $PM_{2.5}$ mass that is measured by the speciation samplers, the U.S. EPA (2014) recommends using the SANDWICH approach (Sulfate, Adjusted Nitrate, Derived Water, Inferred Carbon Hybrid material balance) described by Frank (2006) to apportion the FRM $PM_{2.5}$ mass to individual $PM_{2.5}$ species based on nearby speciation data. A detailed description of the SANDWICH method can be found in the modeling protocol and in the U.S. EPA (2014) modeling guidance. In addition, based on completeness of the data, $PM_{2.5}$ speciation data from 2010 – 2012 were utilized. For each quarter, percent contributions from individual chemical species to FRM $PM_{2.5}$ mass were calculated as the average of the corresponding quarter from 2010-2012. In general, the inter-annual variability of the species fractions is small compared to the variability in the species concentrations, thus the use of average data from 2010 – 2012 is appropriate. Measurements from 2013 and 2014 were not used, because collocated meteorological measurements were not available for those years.

1.6 FUTURE YEAR DESIGN VALUES

Projecting baseline annual $PM_{2.5}$ DVs to the future is a multi-step process as outlined below. See U.S. EPA (2014) and the Photochemical Modeling Protocol Appendix for additional details.

Step 1: Compute observed quarterly weighted average concentrations (consistent with the weighted average DV calculation) at each monitor for the following species: ammonium, nitrate, sulfate, organic carbon, elemental carbon, and other primary PM. This is done by multiplying quarterly weighted average FRM $PM_{2.5}$ concentrations by the fractional composition of $PM_{2.5}$ species for each quarter.

Step 2: Compute the component-specific RRF for each quarter and each species at each monitor based on the reference and future year modeling. The RRF for a specific component *j* is calculated using the following expression:

$$RRF_j = \frac{[C]_{j,\ future}}{[C]_{j,\ reference}} \quad (1)$$

Where $[C]_{j,\ future}$ is the modeled quarterly mean concentration for component *j* predicted for the future year averaged over the 3x3 array of grid cells surrounding the monitor, and $[C]_{j,reference}$ is the same, but for the reference year simulation. An RRF was calculated for each species in Step 1 and at each monitor and for each quarter.

Step 3: Apply the component specific RRF from Step 2 to the observed quarterly weighted average concentrations from Step 1 to obtain projected quarterly species concentrations.

Step 4: Use the online E-AIM model (http://www.aim.env.uea.ac.uk/aim/aim.php) to calculate future year particle-bound water for each quarter at each monitor based on projected ammonium sulfate and ammonium nitrate concentrations.

Step 5: The projected concentration for each quarter is summed over all species, including particle bound water from Step 4, as well as a blank mass of 0.5 µg/m^3 to obtain the future quarterly average $PM_{2.5}$ concentration. Finally, the future annual $PM_{2.5}$ DVs are calculated as the average of the projected $PM_{2.5}$ concentrations from the four quarters.

Projected future year $PM_{2.5}$ DVs are discussed in Section 5.3.

2 METEOROLOGICAL MODELING

California's proximity to the ocean, complex terrain, and diverse climate represent a unique challenge for developing meteorological fields that adequately represent the synoptic and mesoscale features of the regional meteorology. Imperial County contains the northern portion of the Imperial Valley with the Salton Sea defining the northern extent of the Valley. The orientation of the Imperial Valley results in winds that are usually from the southeast or the northwest, depending on synoptic conditions. High PM concentrations in the area occur more often in wintertime when both upper-air and surface pressure gradients are weak and atmospheric conditions are stagnant (Chow and Watson, 1997), while maximum ground-level ozone concentrations are associated with hot summer days and upper-air high pressure systems in the southwest US.

For this modeling assessment, meteorological model results with 4 km horizontal spatial resolution were obtained from the South Coast Air Quality Management District (SCAQMD). These meteorological fields were evaluated against observations and used in the subsequent photochemical model simulations.

2.1 WRF MODEL SETUP

The state-of-the-science Weather Research and Forecasting (WRF) prognostic model (Skamarock et al., 2005) version 3.6.1 was employed in the modeling. Its domain consisted of three nested Lambert projection grids of 36-km (D01), 12-km (D02), and 4-km (D03) uniform horizontal grid spacing as shown in Figure 1. The 4-km innermost domain has 163x115 grid points and spans 652 km in the east-west direction and 460 km in the north-south direction. There are 30 vertical layers with the lowest layer extending to 30 m above the surface. The North America Model (NAM) reanalysis fields, enhanced with surface and upper-air observations, was used for initial and boundary conditions as well as Four Dimension Data Assimilation (FDDA) on the outermost (36-km) domain. The horizontal spatial resolution of the NAM data is 40 km. The planetary boundary layer (PBL) scheme, cumulus parameterization for the outer two domains, and the land surface model were the Yon-Sei University (YSU) PBL, Kain-Fritsch scheme, and the thermal diffusion model, respectively. Details about the meteorological modeling are available in Appendix V: Modeling & Attainment Demonstrations of the South Coast AQMD draft 2016 AQMP (http://www.aqmd.gov/home/library/clean-air-plans/air-quality-mgt-plan/Draft2016AQMP)

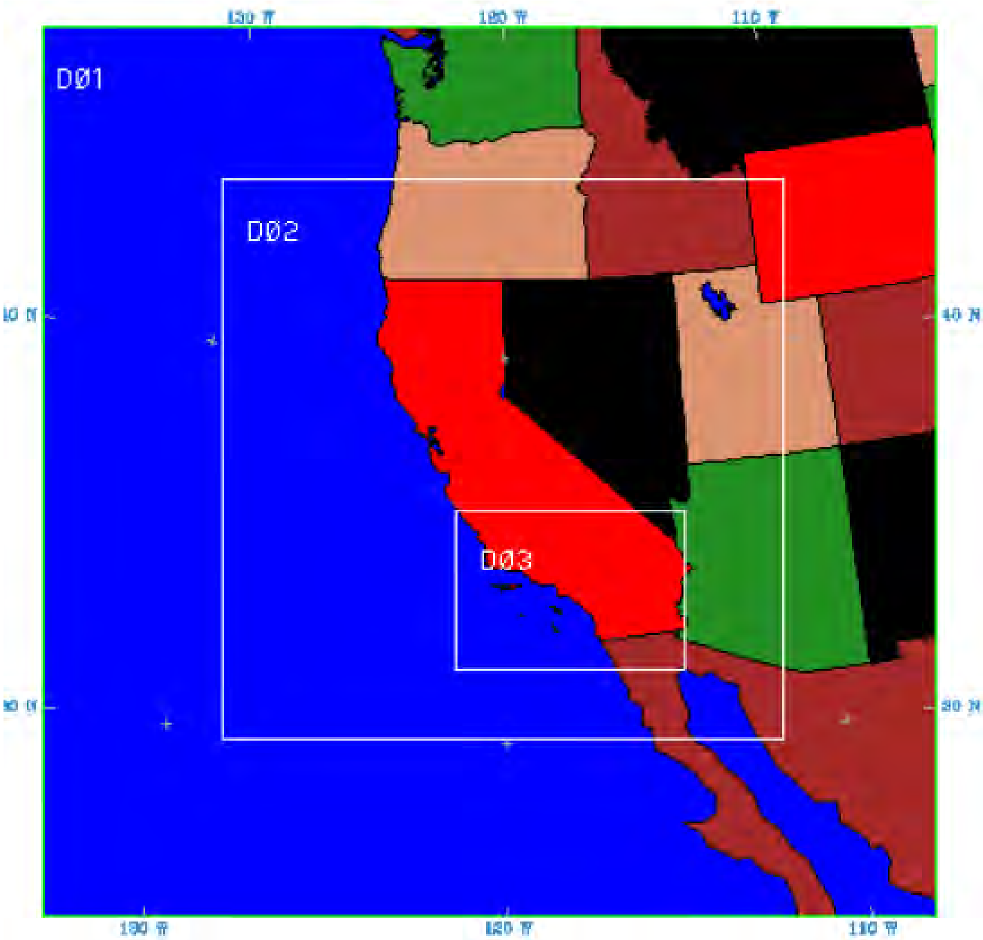

Figure 1. WRF modeling domains (D01 36-km; D02 12-km; and D03 4-km).

2.2 WRF MODEL RESULTS AND EVALUATION

2.2.1 STATISTICS

The simulated surface wind speed, temperature, and relative humidity from the 4-km domain were validated against hourly observations at 15 surface stations in Imperial County. Observational data for the surface stations were obtained from the CARB archived meteorological database (http://www.arb.ca.gov/aqmis2/aqmis2.php). Table 5 lists the monitoring stations and parameters measured at each station, including wind speed and direction (wind), temperature (T), and relative humidity (RH). The location of each of these sites is shown in Figure 2. The following quarterly and annual quantitative performance metrics for 2012 were used to compare hourly surface observations and modeled estimates based on recommendations from Simon et al. (2012): mean bias (MB), mean error (ME), and index of agreement (IOA). A summary of these statistics for Imperial County is shown in Table 6. The model performance statistical metrics were calculated using the available data at all 15 sites in the area.

The distribution of daily mean bias and mean error are shown in Figure 3, while Figure 4 shows hourly observed wind speed, temperature, and relative humidity vs. modeled predictions.

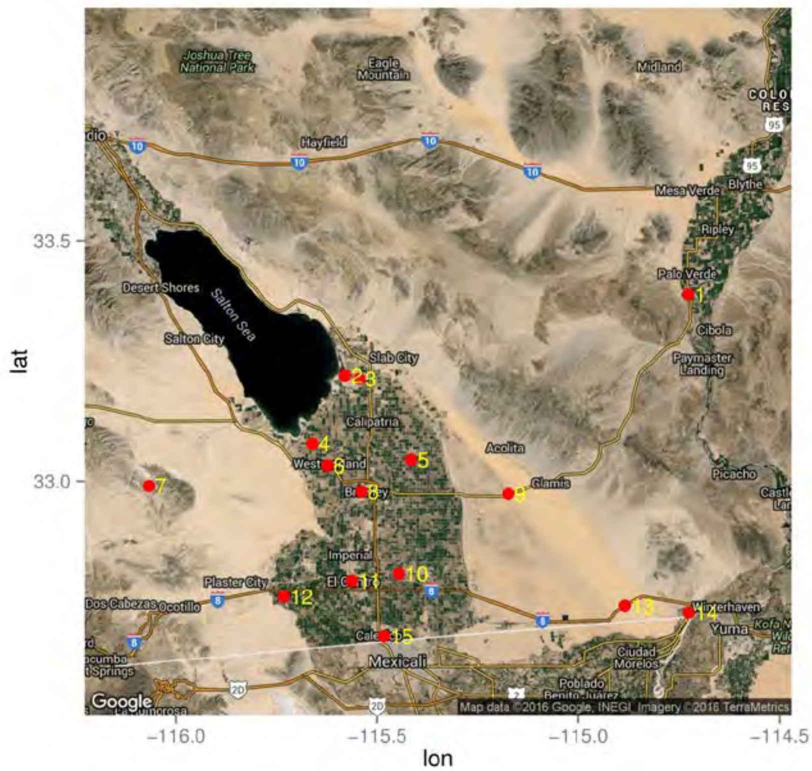

Figure 2. Meteorological observation sites in Imperial County.

Table 5. Meteorological monitor location and parameter(s) measured.

Site Number (Figure 2)	Site ID	Site Name	Parameter(s) Measured
1	5817	Palo Verde II	T, RH
2	5774	Salton Sea East	T, RH
3	3186	Niland-English Road	Wind, T
4	5822	Westmorland North	T, RH
5	5724	Calipatria-Mulberry	T, RH
6	3143	Westmorland-W 1st Street	Wind, T
7	3434	Fish Creek Mountains	Wind, T, RH
8	3675	Brawley-220 Main Street	T
9	3516	Cahuilla	Wind, T, RH
10	5747	Meloland	T, RH
11	2551	El Centro-9th Street	Wind, T
12	5735	Seeley	T, RH
13	3541	Buttercup	Wind, T, RH
14	6735	UC-Andrade	T, RH
15	3135	Calexico-Ethel Street	Wind, T, RH

The wind speed biases are shown to be positive in three of the four quarters in 2012, as well as in the annual statistics. However, the biases are relatively small at less than 0.5 m/s in all quarters. In contrast, the temperature biases are negative for all quarters, as well as for the annual, and range from -2 ˚K to -3 ˚K, while IOA is generally very high with the lowest IOA of 0.87 occurring in the first quarter. Consistent with the negative temperature bias, relative humidity biases are positive and range from ~13% in quarter 3 to ~19% in quarter 2. These results are comparable to other recent WRF modeling efforts in California investigating ozone formation in Central California (e.g., Hu et al., 2012) and modeling analysis for the CalNex and CARES field studies (e.g., Fast et al., 2014; Baker et al., 2013; Kelly et al., 2014; Angevine et al., 2012). Detailed hourly time-series of surface temperature, relative humidity, wind speed, and wind direction for Imperial County can be found in the supplementary material, together with spatial distributions of the quarterly mean bias and mean error.

Table 6. Hourly surface wind speed, temperature and relative humidity statistics summarized by quarter an on an annual basis for 2012.

Quarter	Observed Mean	Modeled Mean	Mean Bias	Mean Error	IOA
Wind Speed (m/s)					
Q1	2.43	2.85	0.42	1.56	0.72
Q2	2.81	2.83	0.03	1.53	0.69
Q3	2.34	2.16	-0.19	1.27	0.56
Q4	1.96	2.17	0.22	1.28	0.66
Annual	2.39	2.49	0.10	1.40	0.68
Temperature (K)					
Q1	289.07	286.39	-2.67	3.44	0.87
Q2	300.14	297.48	-2.66	3.25	0.93
Q3	306.01	303.79	-2.22	2.97	0.88
Q4	291.88	289.90	-1.99	3.25	0.92
Annual	296.84	294.45	-2.39	3.23	0.96
Relative Humidity (%)					
Q1	45.14	61.99	16.85	19.29	0.71
Q2	33.34	52.16	18.83	20.37	0.68
Q3	45.09	58.49	13.40	17.51	0.73
Q4	49.44	64.56	15.12	18.57	0.73
Annual	43.26	59.32	16.06	18.94	0.73

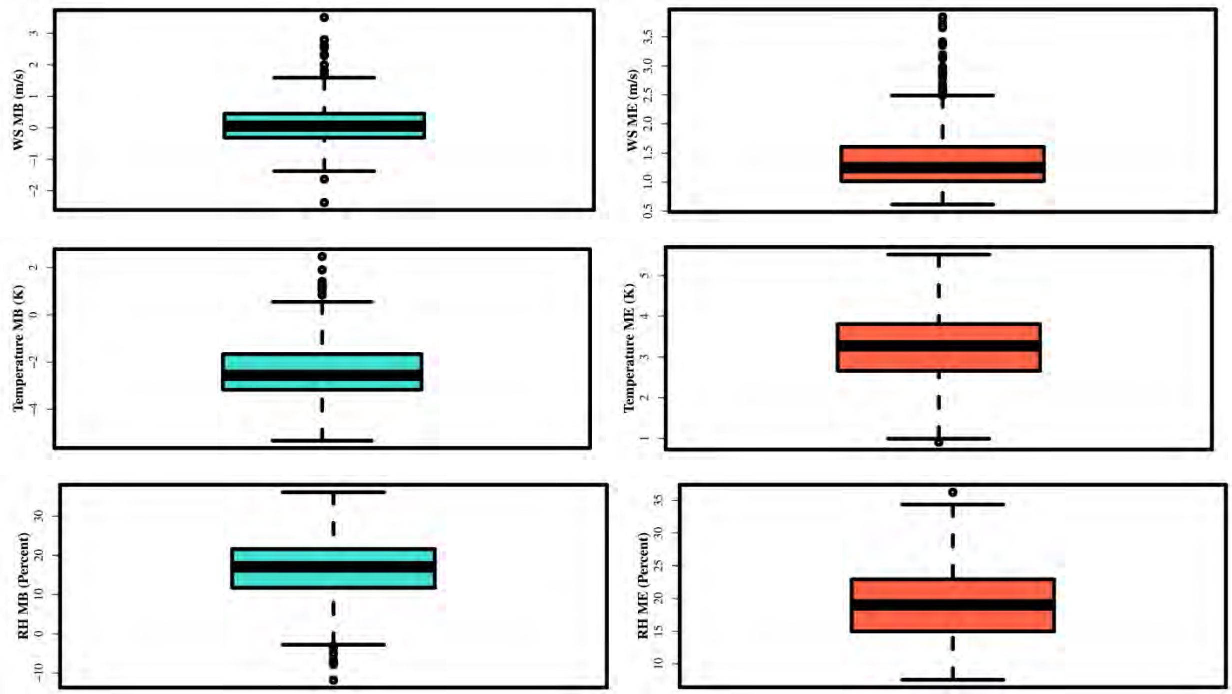

Figure 3. Distribution of modeled daily mean bias (left) and mean error (right) for wind speed (top), temperature (middle), and relative humidity (bottom).

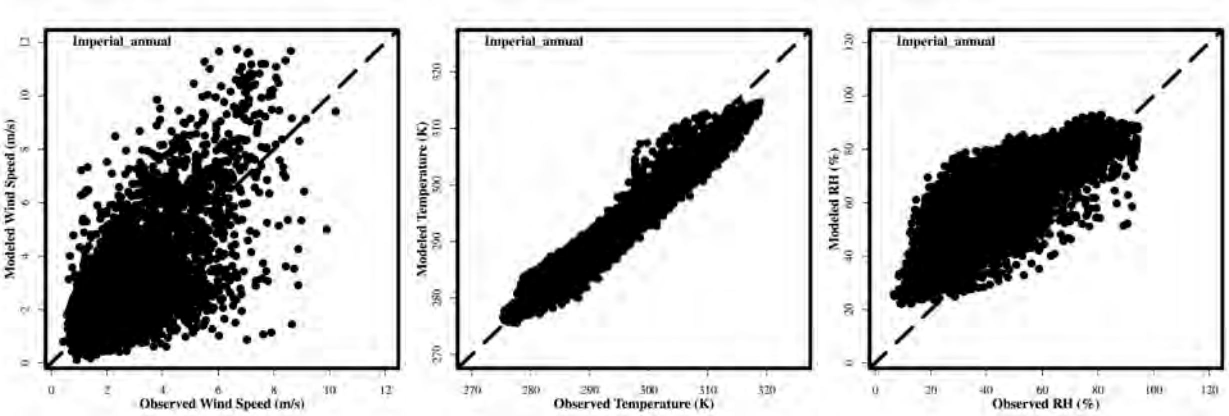

Figure 4. Comparison of modeled and observed hourly wind speed (left), 2-meter temperature (middle), and relative humidity (right).

2.2.2 PHENOMENOLOGICAL EVALUATION

Conducting a detailed phenomenological evaluation for all modeled days can be resource intensive given that it's necessary to simulate an entire year when investigating annual $PM_{2.5}$. However, some insight and confidence that the model is able to reproduce the meteorological conditions leading to elevated particulate matter concentrations can be gained by investigating the meteorological conditions during a period of peak PM in Imperial County. Such meteorological conditions occurred on January 31, 2012. On that day, stagnant meteorological conditions led to a 24-hour average $PM_{2.5}$ concentration at Calexico in excess of 37 µg/m^3. In Imperial County, a large portion of the area is below sea level (Figure 5), with mountainous areas to the east/northeast and west. Figure 5 and Figure 6 show the wind fields in the early morning and afternoon of January 31, 2012. These figures show that the winds during the early morning hours are influenced by down slope flows, while in the afternoon the predominant flow is up slope. In both the model and the observations, wind speeds at Calexico were very low and generally from the south, consistent with cross border transport conditions. Overall, the surface wind distribution indicates that on this day the model was able to capture many of the important features of the observed meteorological fields in the Imperial Valley.

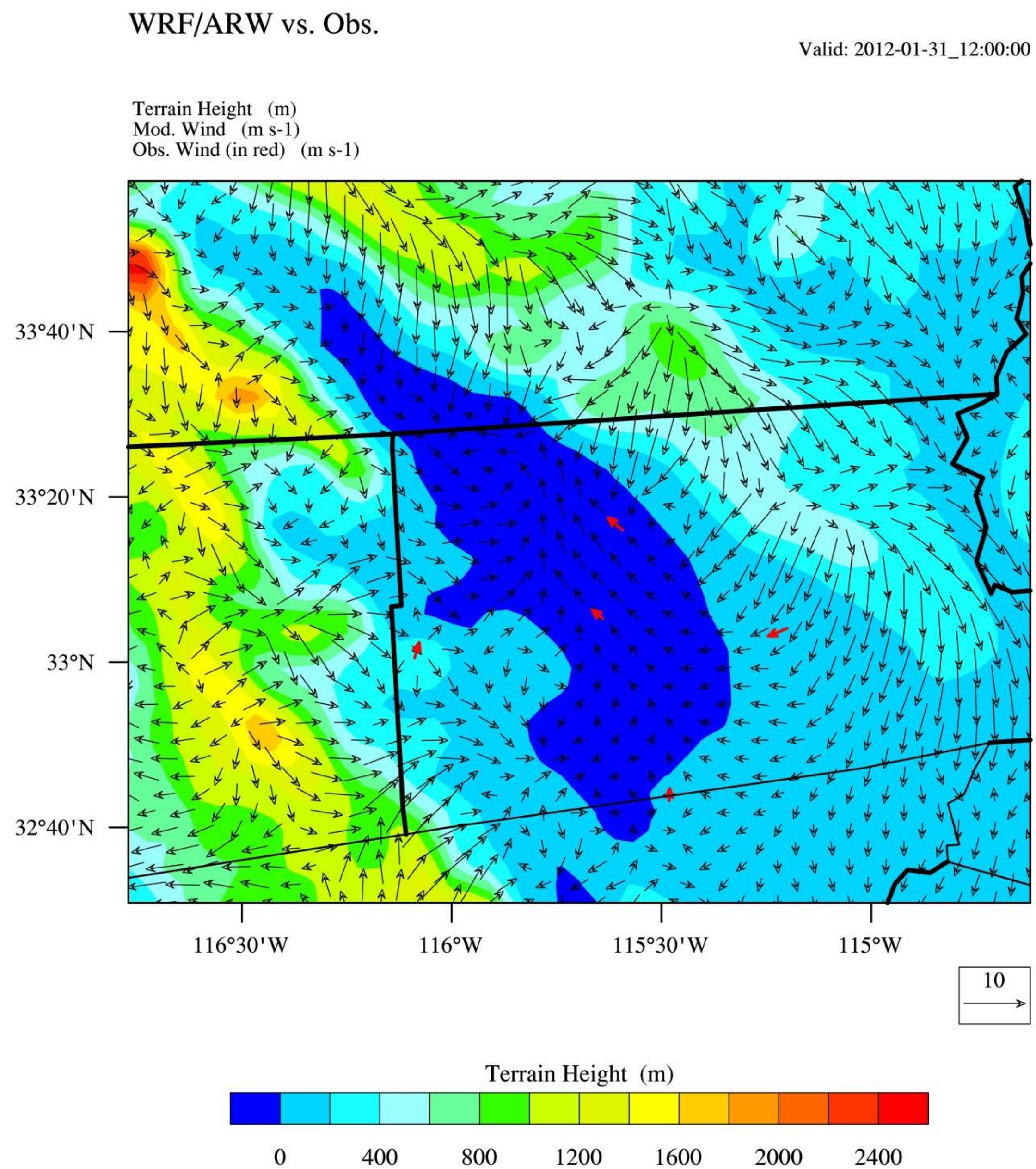

Figure 5. Surface wind field at 04:00 PST January 31, 2012.

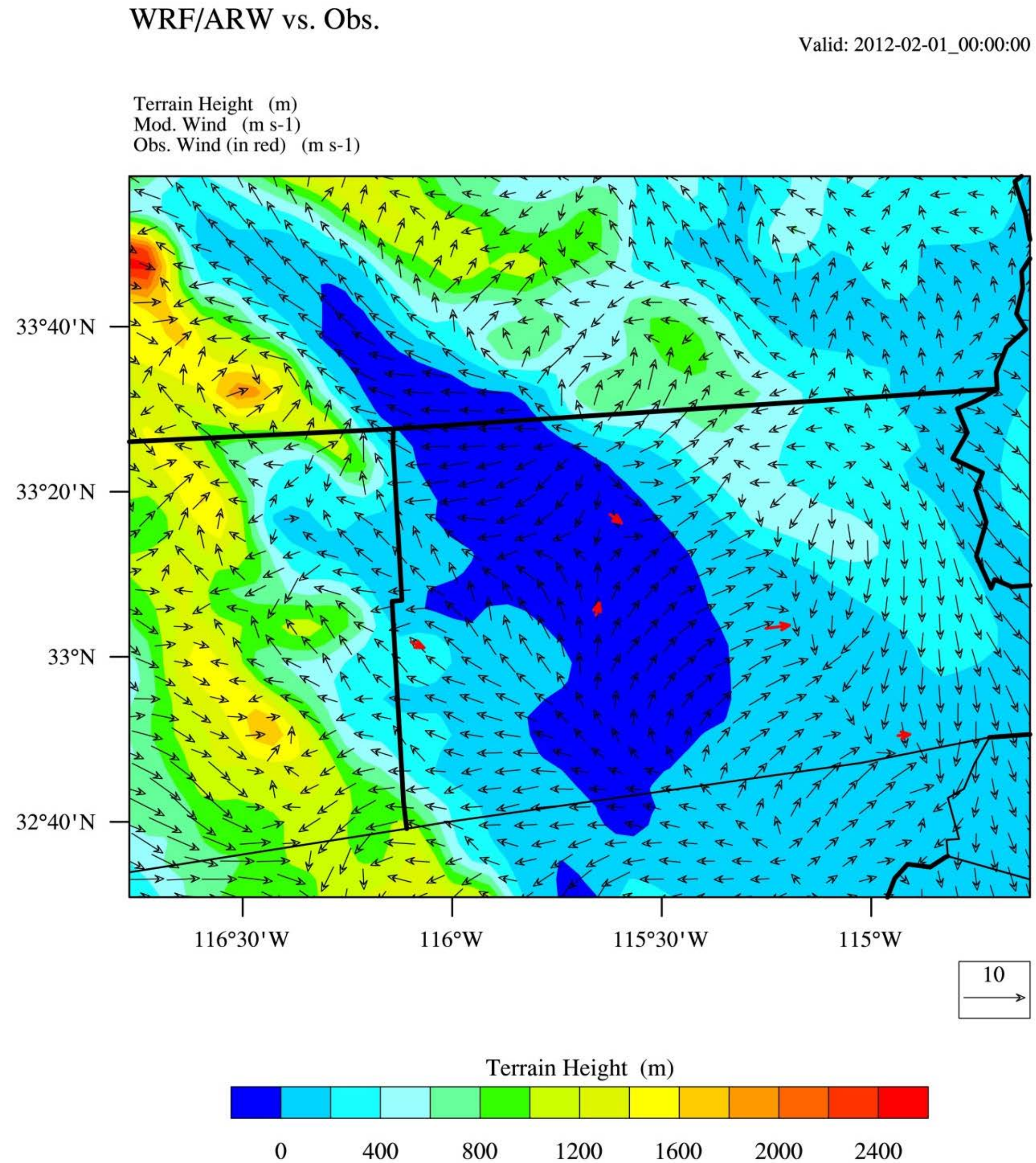

Figure 6. Surface wind field at 16:00 PST January 31, 2012.

3 EMISSIONS

The emissions inventory used in this modeling was based on the most recent inventory submitted to the U.S. EPA, with base year 2012 (http://www.arb.ca.gov/planning/sip/2012iv/2012iv.htm). The model ready emissions inventory includes reasonable measures, identified by the District, which could be implemented by 2021 (these emission reductions are not reflected in Table 7). These measures result in: 1) NO_x reductions for residential water heaters; 2) NO_x reductions for boilers, steam generators, and process heaters; 3) $PM_{2.5}$ reductions for wood burning fireplaces and wood burning heaters; and 4) NH_3 reductions from biosolids, animal manure, and poultry litter composting operations. For a detailed description of the emissions inventory, updates to the inventory, and how it was processed from the planning totals to a gridded inventory for modeling, see the Modeling Emissions Inventory Appendix.

3.1 EMISSIONS SUMMARIES

Table 7 summarizes the 2012 and 2021 anthropogenic emissions (planning inventory totals) for the five $PM_{2.5}$ precursor species in the Imperial County and Mexicali (Municipality and City). Figure 7 shows the region used to estimate the Mexicali (City) emissions. In general, from 2012 to 2021, there is a 37% reduction (from 21.54 to 13.63 ton/day) of anthropogenic NOx emissions in Imperial County, and a 13% reduction (from 16.73 to 14.56 ton/day) of ROG emissions. However, only minor changes (less than 5%) in primary $PM_{2.5}$, SOx, and NH_3 emissions were predicted over the same period.

In contrast, a steady increase in emissions was projected for all $PM_{2.5}$ precursors in both Mexicali Municipality as well as the City of Mexicali from 2012 to 2021. In particular, emissions of anthropogenic NOx in the Mexicali Municipality were predicted to increase to 103.06 ton/day in 2021, which is over seven times the 2021 total anthropogenic NO_x emissions in Imperial County. Similarly, ROG emissions in the Mexicali Municipality were estimated to be four times greater than Imperial County ROG emissions in 2021, at 67.47 ton/day. Direct $PM_{2.5}$ and NH_3 emissions in Mexicali were estimated to be about 1/3 and 1/2 of the Imperial County emissions in 2021, respectively, while SO_x emissions were estimated to be approximately twenty times higher in Mexicali. The difference in direct $PM_{2.5}$ emissions between Imperial and Mexicali is likely due to an absence of fugitive windblown dust emissions in the Mexicali inventory.

Table 7. Imperial County annual planning emission totals and Mexicali Municipality emission totals (from the portion of Mexicali within the modeling domain only) for 2012 and 2021 (estimated emissions for the City of Mexicali are shown in parenthesis).

Category	**NO_x**		**ROG**		**$PM_{2.5}$**		**SO_x**		**NH_3**	
Year	2012	2021	2012	2021	2012	2021	2012	2021	2012	2021
Imperial County (ton/day)										
Stationary	1.91	1.80	1.34	1.36	0.84	1.05	0.01	0.01	1.49	1.50
Area	0.59	0.51	7.34	7.14	37.61	36.81	0.09	0.08	31.44	30.07
On-road Mobile	10.76	5.20	3.58	2.18	0.39	0.19	0.03	0.04	0.23	0.20
Other Mobile	8.29	6.13	4.47	3.89	1.04	1.18	0.21	0.23	0.00	0.00
Total	21.54	13.63	16.73	14.56	39.87	39.23	0.34	0.35	33.15	31.78
Mexicali (ton/day)										
Stationary	16.98 (3.19)	32.45 (4.24)	14.72 (10.20)	19.50 (12.18)	4.46 (0.37)	8.98 (0.50)	4.23 (0.59)	5.70 (0.70)	0.56 (0.01)	1.15 (0.10)
Area	9.52 (0.33)	11.06 (0.42)	25.66 (0.78)	30.54 (0.98)	2.47 (0.07)	2.67 (0.08)	0.40 (0.01)	0.42 (0.01)	14.56 (0.37)	14.97 (0.38)
On-road Mobile	52.83 (3.75)	55.24 (3.92)	16.52 (1.18)	16.99 (1.21)	1.43 (0.10)	1.31 (0.10)	0.65 (0.05)	0.94 (0.07)	0.31 (0.02)	0.41 (0.03)
Other Mobile	3.70 (0.23)	4.30 (0.30)	0.40 (0.02)	0.45 (0.02)	0.49 (0.02)	0.54 (0.02)	0.04 (0.00)	0.05 (0.00)	0.00 (0.00)	0.00 (0.00)
Total	82.98 (7.50)	103.06 (8.89)	57.31 (12.17)	67.47 (14.38)	8.85 (0.57)	13.50 (0.70)	5.32 (0.65)	7.10 (0.78)	15.43 (0.40)	16.53 (0.42)

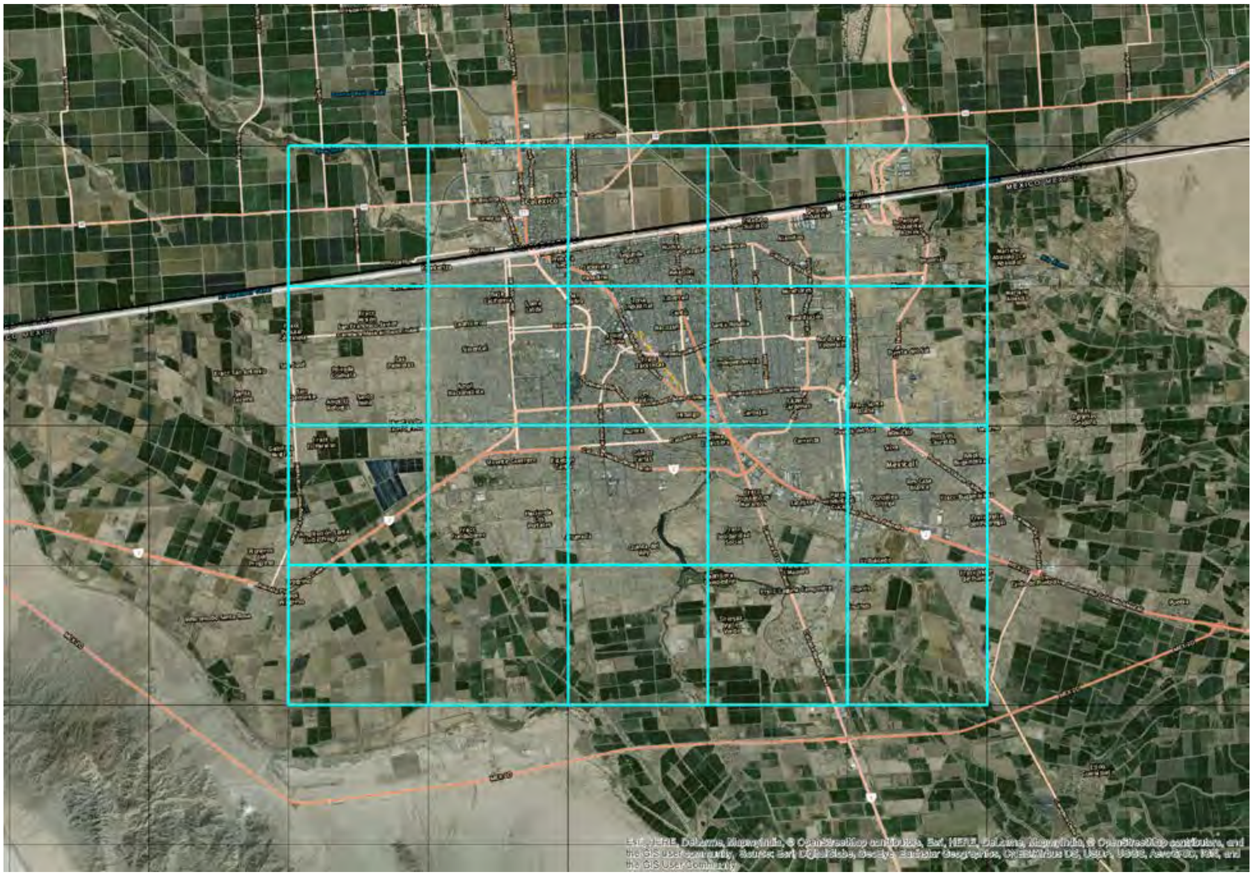

Figure 7. Definition of the geographic region used to estimate emissions for the City of Mexicali in Table 7. Note that emission totals were calculated on the gridded Mexico inventory prior to combining with the California inventory.

Biogenic ROG emissions for the Salton Sea Air Basin (which contains the Imperial Valley) are summarized in Figure 8. Biogenic emissions are highest in the summer at nearly 100 tons/day in June and July when temperature, insolation, and leaf area are generally at their peak, and drop to less than 10 tons/day during winter months.

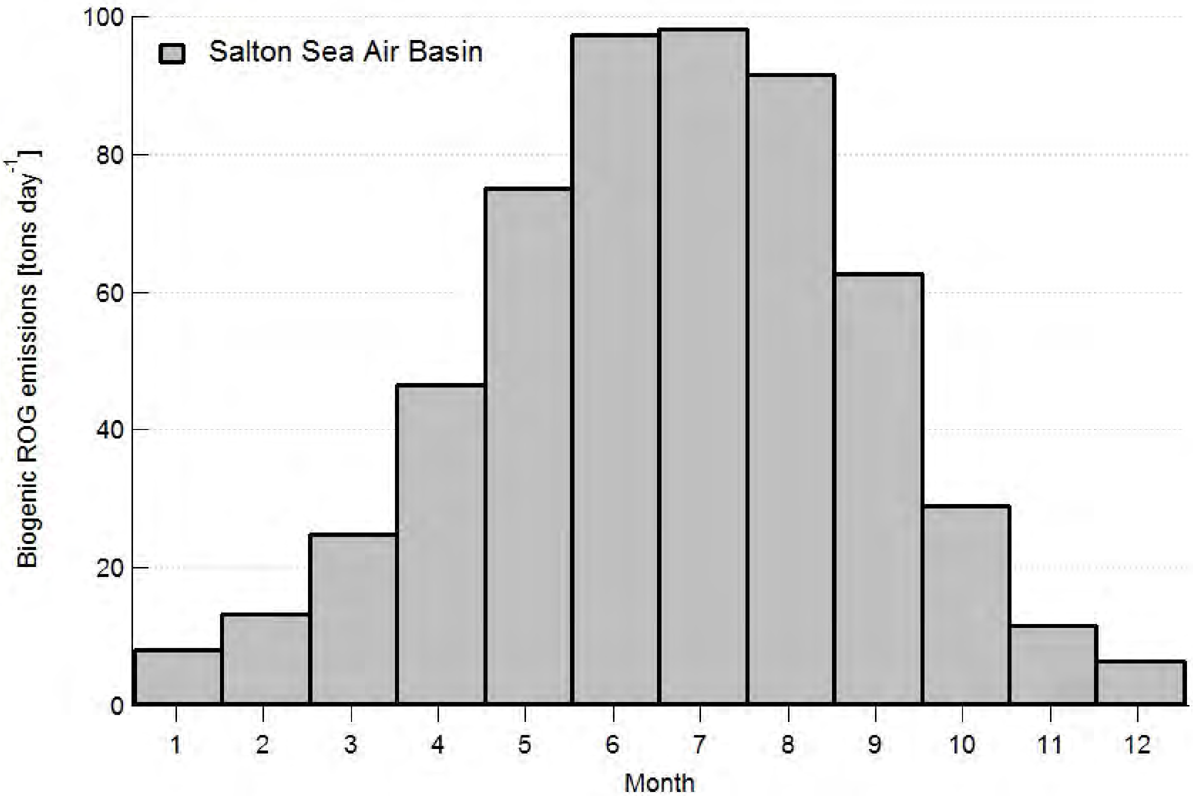

Figure 8. Monthly average biogenic ROG emissions for 2012.

4 $PM_{2.5}$ MODELING

4.1 CMAQ MODEL SETUP

Figure 9 shows the CMAQ modeling domains used in this work. The larger domain covering all of California has a horizontal grid resolution of 12-km with 107 x 97 lateral grid cells for each vertical layer and extends from the Pacific Ocean in the west to Eastern Nevada in the east and runs from the U.S.-Mexico border in the south to the California-Oregon border in the north. The smaller nested domain covering the Salton Sea, South Coast, San Diego, and Mojave Desert air basins utilizes a finer scale 4-km grid resolution with 156 x 102 lateral grid cells. Both the 12-km and 4-km domains are based on a Lambert Conformal Conic projection with reference longitude and latitude at – 120.5ºN and 37ºN, respectively, which is consistent with WRF domain settings. The 30 vertical layers from WRF were mapped onto 18 vertical layers for CMAQ, extending from the surface to 100 mb such that a majority of the vertical layers fall within the planetary boundary layer (see the Photochemical Modeling Protocol for details).

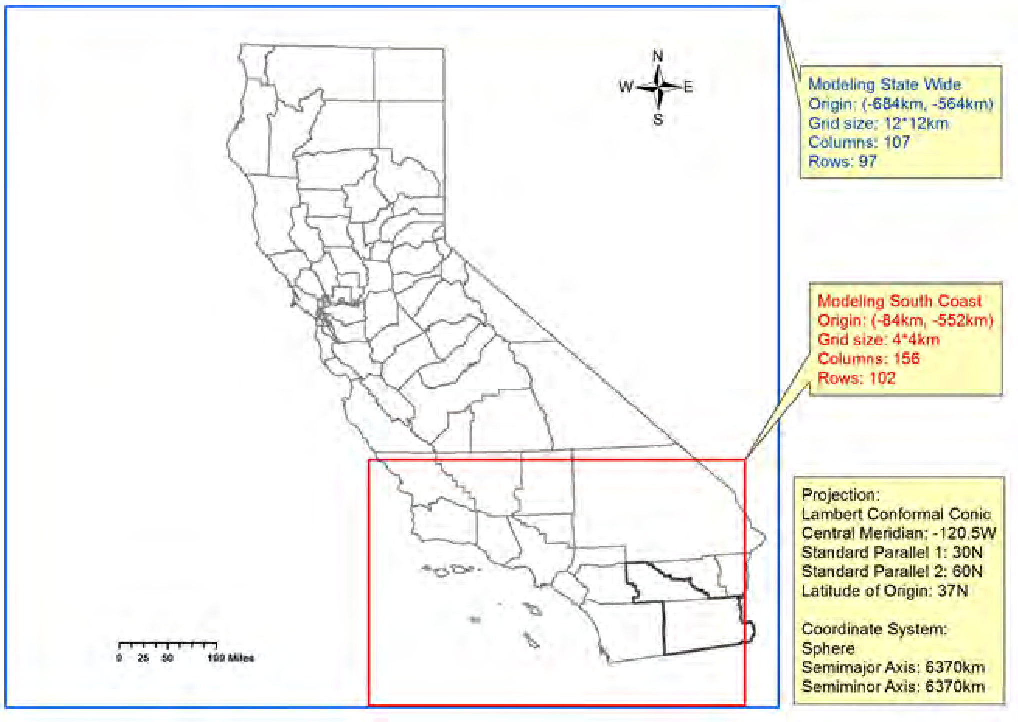

Figure 9. CMAQ modeling domains utilized in the modeling assessment.

The CMAQ model version 5.0.2 (http://www.airqualitymodeling.org/cmaqwiki/index.php?title=CMAQ_version_5.0.2_%28April_2014_release%29_Technical_Documentation), released by the U.S. EPA in May 2014, was used for all air quality model simulations. The SAPRC07 chemical mechanism and aerosol module aero6 were selected as the gas-phase and aerosol modules, respectively. Further details of the CMAQ configuration can be found in Table 8 and in the Photochemical Modeling Protocol. The same configuration was used for all simulations.

Annual simulations were conducted on a simultaneous monthly basis, rather than one single continuous simulation. For each month, the CMAQ simulations included a seven day spin-up period (i.e., the last seven days of the previous month) for the outer 12-km domain, where initial conditions were set to the default CMAQ initial conditions. These outer domain simulations were used to provide initial and lateral boundary conditions for the inner 4-km simulation, which utilized a three day spin-up period.

Chemical boundary conditions for the outer 12-km domain were extracted from the global chemical transport Model for Ozone and Related chemical Tracers, version 4 (MOZART-4; Emmons et al., 2014). The MOZART-4 model output for 2012 was obtained from the National Center for Atmospheric Research (NCAR;

https://www2.acom.ucar.edu/gcm/mozart) using the simulations driven by meteorological fields from the NASA GMAO GEOS-5 model. The same MOZART derived BCs for the 12 km outer domain were used in all simulations.

Table 8. CMAQ configuration and settings.

Process	**Scheme**
Horizontal advection	Yamo (Yamartino scheme for mass-conserving advection)
Vertical advection	WRF-based scheme for mass-conserving advection
Horizontal diffusion	Multi-scale
Vertical diffusion	ACM2 (Asymmetric Convective Model version 2)
Gas-phase chemical mechanism	SAPRC-07 gas-phase mechanism version “B”
Chemical solver	EBI (Euler Backward Iterative solver)
Aerosol module	Aero6 (the sixth-generation CMAQ aerosol mechanism with extensions for sea salt emissions and thermodynamics; includes a new formulation for secondary organic aerosol yields)
Cloud module	ACM_AE6 (ACM cloud processor that uses the ACM methodology to compute convective mixing with heterogeneous chemistry for AERO6)
Photolysis rate	phot_inline (calculate photolysis rates in-line using simulated aerosols and ozone concentrations)

4.2 CMAQ MODEL EVALUATION

CMAQ model performance was evaluated for $PM_{2.5}$ mass, individual $PM_{2.5}$ chemical species, as well as a number of gas-phase species based on observations from the network of monitors in Imperial County.

Time series of observed and modeled $PM_{2.5}$ chemical species based on SLAMS (State and Local Air Monitoring Stations) measurements at the Calexico monitor are shown in Figure 10. $PM_{2.5}$ species are measured every 6 days at this site. Though the highest daily $PM_{2.5}$ concentrations primarily occur in winter months, there is little variability during other months. The modeling system does a reasonable job at capturing total $PM_{2.5}$ at Calexico during all seasons, but some peak values are under-predicted during winter months. Though the ammonium nitrate is well captured during all seasons, there is a general underestimate of EC and OC in winter months. Windblown dust is consistently over-predicted ("Other" category in Figure 10), which is likely due to uncertainty in the magnitude and distribution (spatial and temporal) of fugitive windblown dust sources.

Table 9 summarizes key model performance metrics for the major $PM_{2.5}$ chemical species at Calexico. Model performance was evaluated quarterly as well as on an annual basis. Average observations and modeled values, mean bias, mean error, mean fractional bias (MFB), and mean fractional error (MFE) are given for individual $PM_{2.5}$ species. Detailed definitions for these metrics can be found in the Photochemical Modeling Protocol Appendix. In general, model performance was consistent across each of the four quarters, with mean bias for total $PM_{2.5}$ ranging from -3.2 µg/m^3 in quarter 1 to 3.7 µg/m^3 in quarter 3. The positive bias in quarter 3 is likely due in large part to an over-prediction in the windblown dust component ("Other" category in Figure 10). Under-prediction in the OC component is the main reason for negative bias in total $PM_{2.5}$, and is largest during winter months, which suggests the OC under-prediction is due to uncertainty in the primary OC emissions and likely the Mexicali inventory. Annually, the mean bias in $PM_{2.5}$ and its components, excluding OC, range from -0.5 to 0.5 µg/m^3.

A graphical representation of the quarterly MFB and MFE values in Table 9 is shown in Figure 11, along with suggested model performance goals and criteria (green and red lines, respectively) from Boylan and Russell (2006). Since there are no species measurements at the Brawley and El Centro monitors, only the MFB and MFE values for total $PM_{2.5}$ are shown for those sites. For the Brawley and El Centro monitors, the modeled $PM_{2.5}$ represents total $PM_{2.5}$ minus the crustal component from windblown dust. The modeled crustal component was ignored at these two sites because uncertainties in the windblown dust inventory were likely resulting in erroneously high

$PM_{2.5}$ concentrations in the modeling system (discussed in more detail below). According to Boylan and Russell (2006), model performance goals are defined as the level of accuracy that is considered to be close to the best a model can achieve, while model performance criteria are defined as the level of accuracy that is considered to be acceptable for modeling applications. Based on these metrics, the current modelling system met the model performance criteria for nearly all quarters and components, and in many instances exceeded the model performance goals.

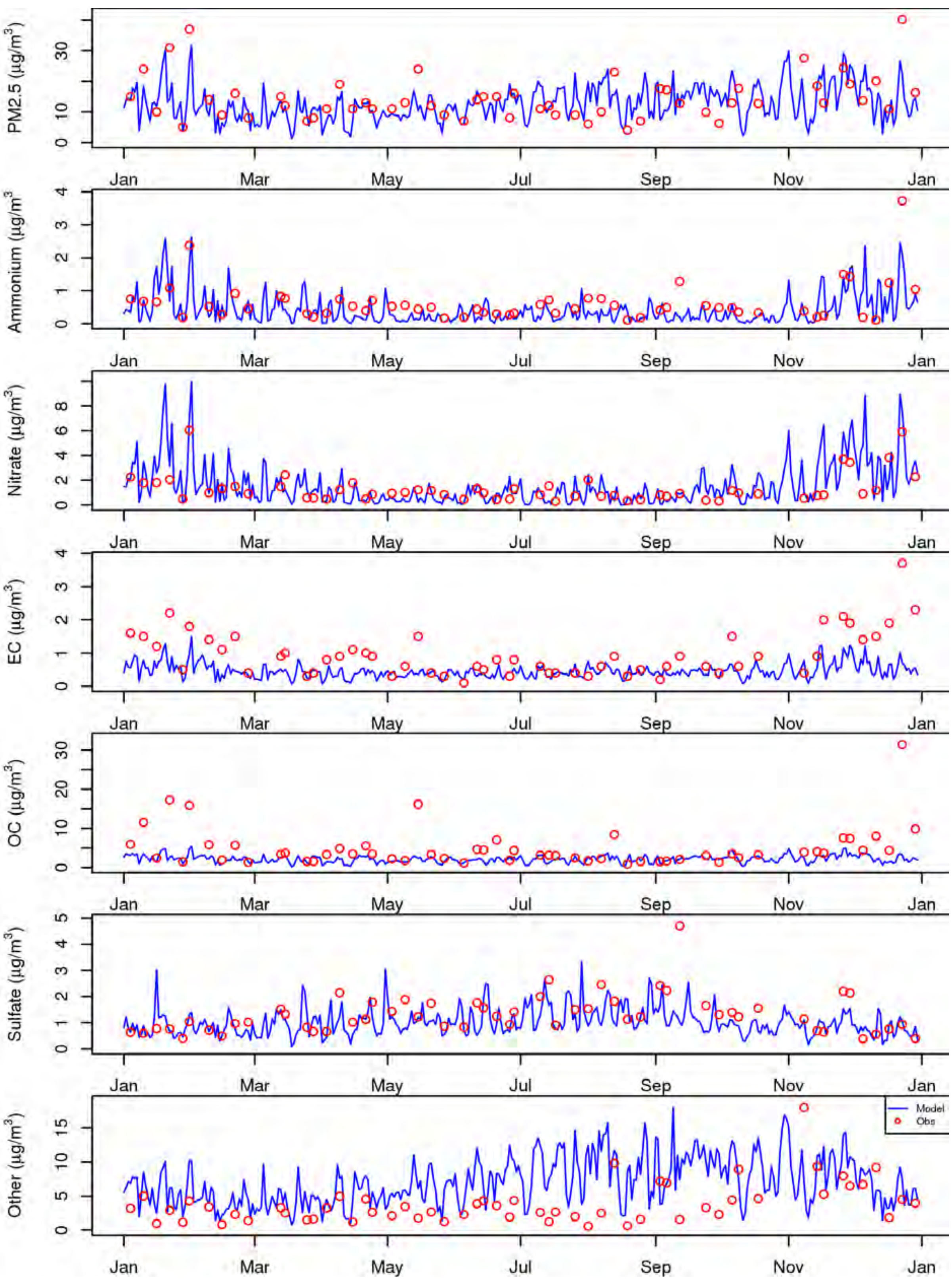

Figure 10. Time series of observed (SLAMS) and modeled $PM_{2.5}$ species at the Calexico monitor.

Table 9. Summary of quarterly and annual $PM_{2.5}$ model performance statistics at the Calexico monitor (SLAMS).

Quarter	Species	# of Obs.	Avg. Obs. (µg/m³)	Avg. Mod. (µg/m³)	Mean bias (µg/m³)	Mean error (µg/m³)	MFB	MFE
1	$PM_{2.5}$	15	15.3	12.0	-3.2	4.5	-0.17	0.31
1	Ammonium	15	0.7	0.7	0.0	0.4	-0.05	0.58
1	Nitrate	15	1.7	2.3	0.6	0.8	0.23	0.49
1	Sulfate	15	0.8	1.1	0.2	0.4	0.17	0.30
1	OC	15	5.5	1.8	-3.7	3.8	-0.79	0.83
1	EC	15	1.1	0.5	-0.6	0.6	-0.73	0.77
2	$PM_{2.5}$	16	13.1	11.7	-1.4	3.6	-0.11	0.27
2	Ammonium	16	0.4	0.2	-0.2	0.3	-0.83	0.91
2	Nitrate	16	0.9	0.8	-0.1	0.5	-0.32	0.64
2	Sulfate	16	1.3	1.0	-0.4	0.4	-0.35	0.38
2	OC	16	4.4	1.4	-3.0	3.0	-0.86	0.87
2	EC	16	0.7	0.4	-0.3	0.4	-0.45	0.62
3	$PM_{2.5}$	14	11.1	14.7	3.7	7.4	0.32	0.58
3	Ammonium	15	0.6	0.2	-0.3	0.4	-0.77	0.92
3	Nitrate	15	0.8	1.0	0.2	0.6	0.11	0.73
3	Sulfate	15	2.0	1.1	-0.9	1.0	-0.49	0.56
3	OC	15	2.9	1.5	-1.4	1.6	-0.47	0.56
3	EC	15	0.6	0.4	-0.2	0.3	-0.22	0.50
4	$PM_{2.5}$	15	18.0	17.3	-0.7	7.5	-0.03	0.42
4	Ammonium	15	0.8	0.7	0.0	0.4	-0.01	0.55
4	Nitrate	15	1.8	3.3	1.5	1.8	0.55	0.67
4	Sulfate	15	1.0	0.9	-0.1	0.3	0.02	0.34
4	OC	14	6.8	2.2	-4.7	4.7	-0.77	0.77
4	EC	14	1.5	0.7	-0.9	0.9	-0.66	0.75
Annual	$PM_{2.5}$	60	14.4	13.9	-0.5	5.7	0.00	0.39
Annual	Ammonium	61	0.6	0.5	-0.1	0.3	-0.42	0.74
Annual	Nitrate	61	1.3	1.8	0.5	0.9	0.14	0.63
Annual	Sulfate	61	1.3	1.0	-0.3	0.5	-0.17	0.39
Annual	OC	60	4.9	1.7	-3.2	3.2	-0.72	0.76
Annual	EC	60	1.0	0.5	-0.5	0.5	-0.51	0.66

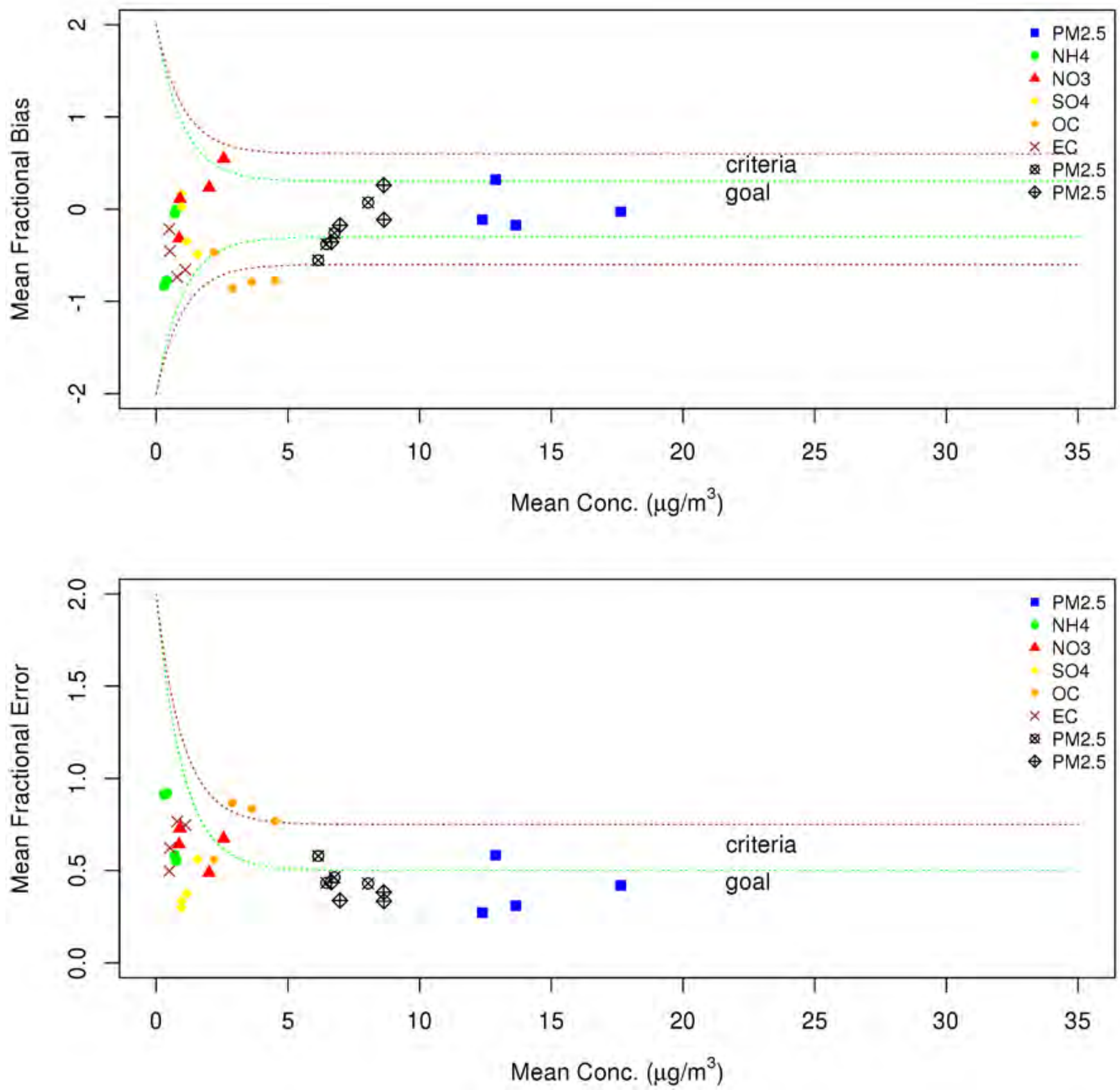

Figure 11. Bugle plots of quarterly $PM_{2.5}$ model performance in terms of MFB and MFE at monitoring sites in Imperial County. Colored markers represent SLAMS measurements at the Calexico monitor, while black points represent total FRM $PM_{2.5}$ (minus the windblown dust component) at the Brawley (circles) and El Centro (diamonds) monitors.

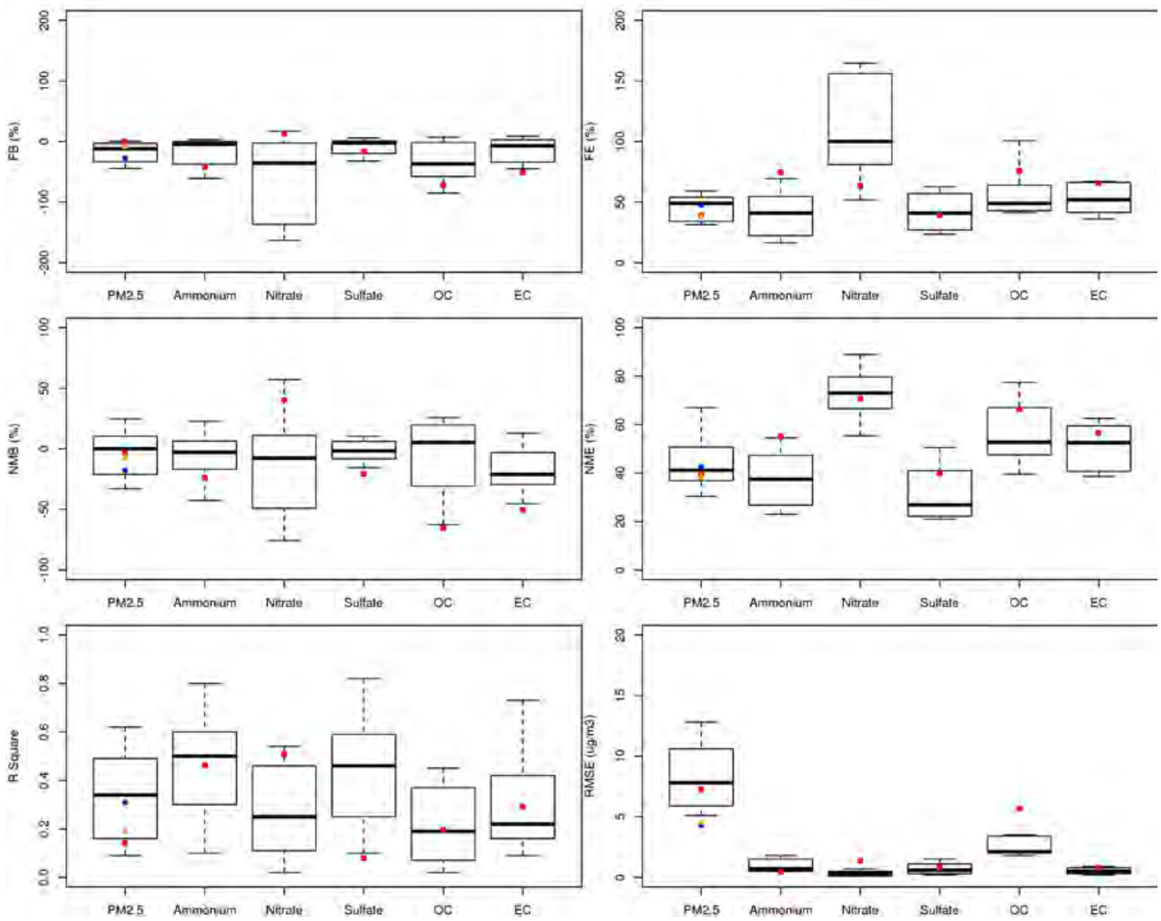

Figure 12. Comparison of annual $PM_{2.5}$ model performance to the summary of modeling studies in Simon et al. (2012). Red symbols represent performance at the Calexico – Ethel Street SLAMS site, while blue and orange symbols represent performance at the Brawley and El Centro FRM sites, respectively.

In addition to evaluating the standard statistical performance metrics, it is also informative to put these performance statistics in the context of other studies published in the scientific literature. Figure 12 compares key performance statistics presented above, as well as additional metrics, to the range of published performance statics from 2006 to 2012 and summarized in Simon et al. (2012). In Figure 12, the black centerline shows the median model performance from those studies, the boxes outline the 25th and 75th percentile values, and the whiskers show the 10th and 90th percentile values. The model performance at Calexico is shown with a red marker, while the blue and orange markers represent model performance for total $PM_{2.5}$ (minus the windblown dust component) at the Brawley and El Centro monitors, respectively. Performance metrics including MFB, MFE, normalized mean bias (NMB), normalized mean error (NME), R squared, and root mean square error (RMSE) are compared. Definitions of the statistics can be found in the Photochemical Modeling Protocol or Simon et al. (2012).

Model performance metrics in the Imperial County are typically equal to or better than the corresponding statistics from other studies.

Since SLAMS monitors do not measure $PM_{2.5}$ on a daily basis, it is also advantageous to compare modeled 24-hour average $PM_{2.5}$ concentrations to observations from continuous $PM_{2.5}$ samplers, which typically report 24-hour average $PM_{2.5}$ concentrations on a daily basis. Figures 12-14 show the time series of modeled and observed 24-hour average $PM_{2.5}$ concentrations at the Calexico, Brawley, and El Centro monitors. At Calexico, observed daily $PM_{2.5}$ concentrations were well captured by the model, except for 3 unexplained high values, two of which occurred outside of the winter season, and are likely due to episodic emissions, such as agricultural or waste refuse burning in Mexicali or Imperial, that is not well captured in the emissions inventory. At the Brawley and El Centro monitors, daily $PM_{2.5}$ was significantly over-predicted throughout the entire year. This over-prediction is likely due to uncertainties in the magnitude and location of fugitive windblown dust emissions. When the windblown dust component is removed from the total $PM_{2.5}$ calculation, model predictions at both sites are greatly improved and compare well to observations (Figures 15 and 16). The quarterly and annual model performance statistics based on FRM measurements are summarized in Table 10.

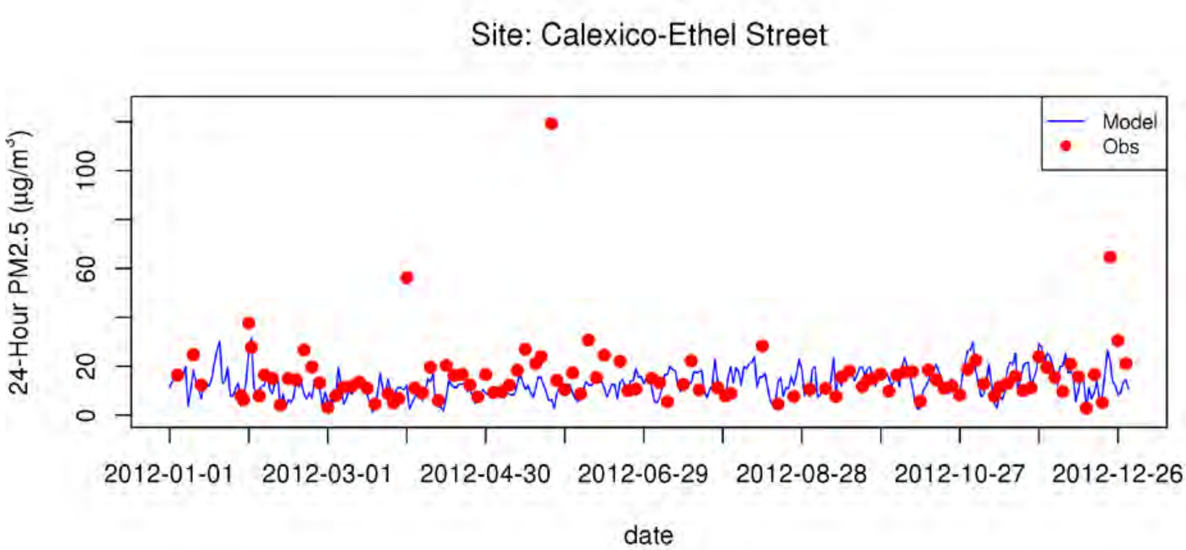

Figure 13. Observed and modeled 24-hour average $PM_{2.5}$ at the Calexico – Ethel Street FRM monitor.

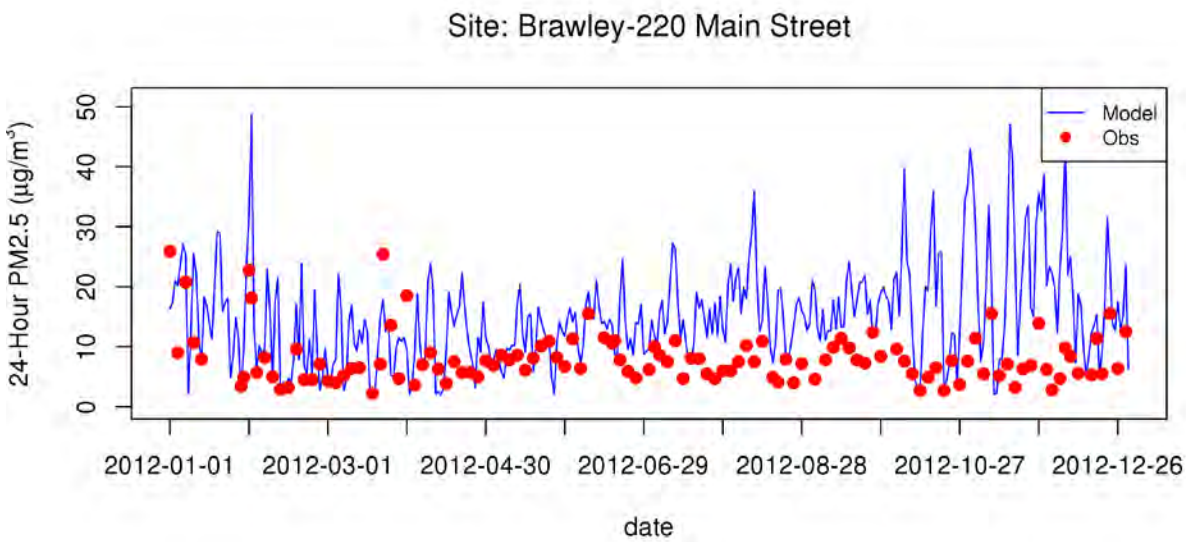

Figure 14. Observed and modeled 24-hour average $PM_{2.5}$ at the Brawley – 220 Main Street FRM monitor.

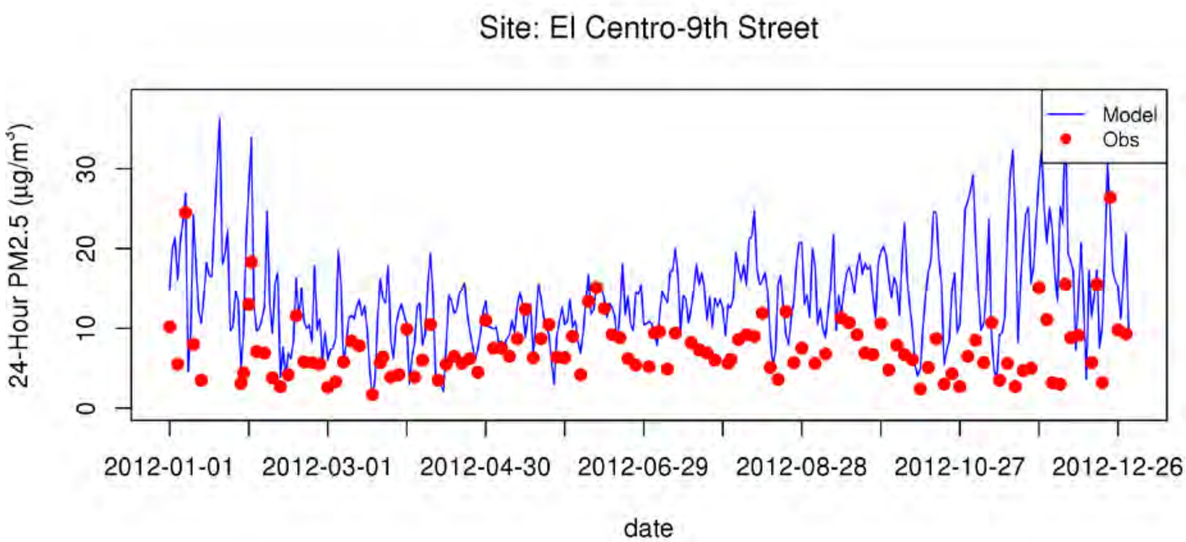

Figure 15. Observed and modeled 24-hour average $PM_{2.5}$ at the El Centro – 9th Street FRM monitor.

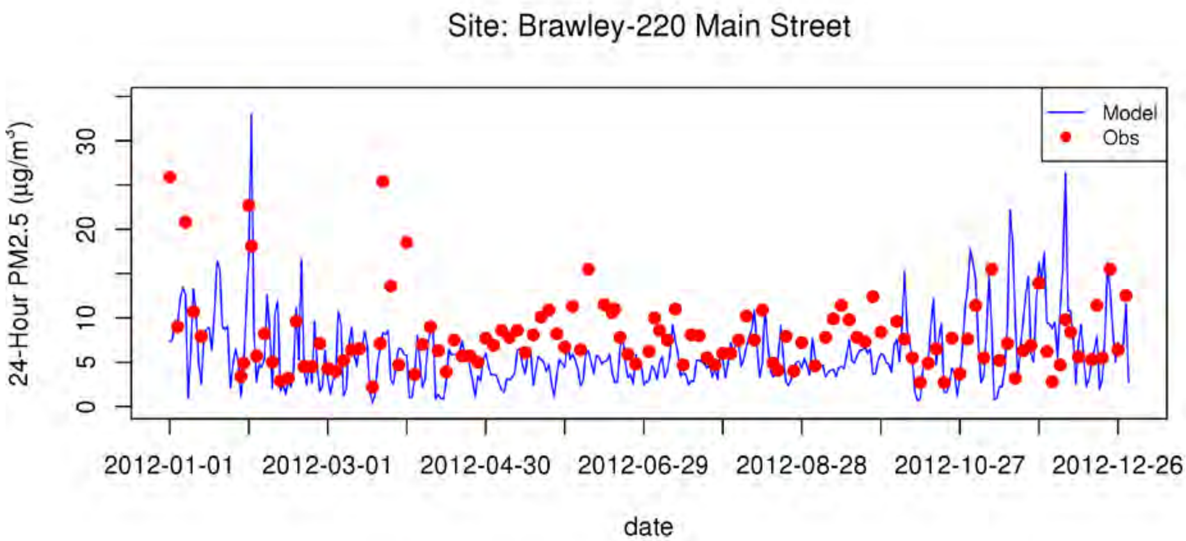

Figure 16. Observed and modeled (without windblown dust) 24-hour average $PM_{2.5}$ at the Brawley – 220 Main Street FRM monitor.

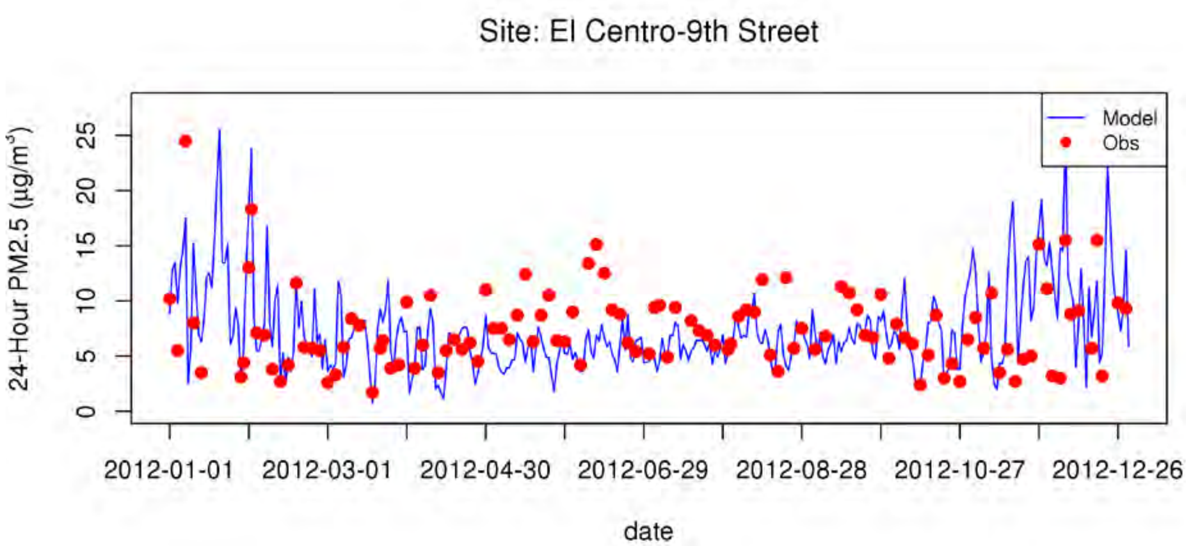

Figure 17. Observed and modeled (without windblown dust) 24-hour average $PM_{2.5}$ at the El Centro – 9th Street FRM monitor.

Table 10. Model performance statistics for 24-hour $PM_{2.5}$ concentrations measured at the three FRM sites in Imperial County.

Quarter	# of Obs.	Avg. Obs. (µg/m^3)	Avg. Mod. (µg/m^3)	Mean bias (µg/m^3)	Mean error (µg/m^3)	MFB	MFE
Calexico							
1	27	15.0	10.4	-4.6	6.2	-0.29	0.44
2	28	19.3	10.4	-8.9	9.8	-0.40	0.46
3	22	12.6	13.7	1.1	5.0	0.12	0.38
4	30	16.4	14.9	-1.5	6.4	-0.07	0.36
Annual	107	16.0	12.3	-3.7	6.9	-0.17	0.41
El Centro							
1	29	7.0	6.5	-0.5	2.9	-0.26	0.46
2	29	7.9	4.4	-3.4	3.6	-0.55	0.58
3	29	7.7	5.2	-2.5	2.9	-0.38	0.43
4	31	7.6	8.5	0.9	3.5	0.07	0.43
Annual	118	7.5	6.2	-1.3	3.2	-0.27	0.48
Brawley							
1	29	9.4	7.9	-1.5	3.3	-0.11	0.33
2	29	7.9	5.4	-2.4	3.0	-0.36	0.44
3	30	7.7	6.3	-1.4	2.4	-0.18	0.34
4	31	7.3	9.9	2.6	3.6	0.26	0.38
Annual	119	8.0	7.4	-0.6	3.1	-0.09	0.37

4.3 RELATIVE RESPONSE FACTORS, FUTURE YEAR DESIGN VALUES, AND THE IMPACT FROM MEXICO ANTHROPOGENIC EMISSIONS

Future year DVs for each site are shown in Table 11. The corresponding Relative Response Factor (RRF) for annual $PM_{2.5}$ composition at each monitor is shown in Table 12, while the base and projected future year composition are shown in Tables 13 and 14, respectively (note that the annual RRFs and composition are for reference only and that in the actual future DV calculation, separate calculations were performed for each quarter and not on the annual average). The modeling results show a relatively small decrease in DV at all three sites, with the Calexico – Ethel Street monitor exhibiting both the greatest decrease (0.5 $\mu g/m^3$) and highest projected future year DV at 13.7 $\mu g/m^3$, which is well above the 2012 annual $PM_{2.5}$ standard of 12 $\mu g/m^3$. When the influence of emissions from Mexico is removed, the projected future year DV at the Calexico monitor decreased 2 $\mu g/m^3$ to 11.7 $\mu g/m^3$, which is below the annual $PM_{2.5}$ standard. The El Centro and Brawley monitors also show a reduction in DV with the removal of Mexico anthropogenic emissions, but the reduction is much smaller than at Calexico, and is reduced the further away a monitor is located from the Mexicali source region such that the Brawley monitor exhibited the smallest change. Note that the simulated decrease in DVs in the absence of Mexico emissions likely underestimates the actual contribution from Mexico emissions, since only emissions within the modeling domain were removed and the contribution from Mexico emissions outside of the domain continue to be reflected in the outer 12-km domain boundary conditions. Given that the 12-km domain only extends ~50 miles into Mexico (Figure 9), emission from outside of the modeling domain, which appear in the boundary conditions, are likely still influencing simulated $PM_{2.5}$ within Imperial County, and so the 11.7 $\mu g/m^3$ DV at Calexico should be considered a conservative estimate of the DV in the absence of Mexico emissions.

Furthermore, given that the density of US-based $PM_{2.5}$ emissions surrounding each monitor is consistent across all monitors (see Weight of Evidence Appendix, Section IX), it is reasonable to expect that in the absence of Mexico emissions, $PM_{2.5}$ concentrations at each monitor would be roughly equivalent. However, modeling suggests that even in the absence of Mexico emissions the Calexico monitor would exhibit $PM_{2.5}$ concentrations approximately 40% greater than at the El Centro and Brawley monitors. Since US-based emission sources surrounding each monitor are not significantly different, it is likely that the lack of sensitivity in the modeling to removing Mexico emissions is largely due to an underestimate of emissions from Mexico, and that the actual sensitivity would be much greater if Mexico emissions were quantified more accurately.

Table 11. Projected future year (2021) $PM_{2.5}$ DVs at each monitor. The baseline DV is the average of the 2012, 2013, and 2014 DVs

Site AQS ID	Site Name	Baseline DV (µg/m^3)	Future year DV (µg/m^3)	Future year DV (µg/m^3) w/o Mexico Emission
60250005	Calexico *Ethel Street*	14.2	13.7	11.7
60251003	El Centro *9th Street*	7.3	7.1	6.6
60250007	Brawley *220 Main Street*	7.4	7.0	6.8

Table 12. Annual RRFs for each $PM_{2.5}$ component.

Site	RRF for $PM_{2.5}$	RRF for NH_4	RRF for NO_3	RRF for SO_4	RRF for OM	RRF for EC	RRF for Crustal
Calexico	0.96	0.85	0.85	0.98	0.97	0.79	0.97
El Centro	0.97	0.85	0.88	0.99	0.98	0.74	1.01
Brawley	0.95	0.73	0.78	0.98	0.96	0.66	1.01
In the absence of Mexico emissions							
Calexico	0.82	0.38	0.48	0.76	0.84	0.38	0.94
El Centro	0.91	0.48	0.61	0.84	0.94	0.60	1.00
Brawley	0.91	0.50	0.66	0.88	0.93	0.59	1.00

Table 13. Base year $PM_{2.5}$ composition*.

Name	Base $PM_{2.5}$ (µg/m^3)	Base NH_4 (µg/m^3)	Base NO_3 (µg/m^3)	Base SO_4 (µg/m^3)	Base OM (µg/m^3)	Base EC (µg/m^3)	Base Crustal (µg/m^3)
Calexico	14.2	0.3	0.1	1.2	8.5	0.8	2.5
El Centro	7.3	0.1	0.0	0.6	4.2	0.4	1.2
Brawley	7.4	0.1	0.0	0.6	4.3	0.4	1.2

* Base year $PM_{2.5}$ composition was based on SLAMS speciation measurements adjusted by the EPA SANDWICH method. Particle-bound water and blank mass are not shown.

Table 14. Adjusted future year (2021) $PM_{2.5}$.

Name	Projected $PM_{2.5}$ ($\mu g/m^3$)	Projected NH_4 ($\mu g/m^3$)	Projected NO_3 ($\mu g/m^3$)	Projected SO_4 ($\mu g/m^3$)	Projected OM ($\mu g/m^3$)	Projected EC ($\mu g/m^3$)	Projected Crustal ($\mu g/m^3$)	Projected Water ($\mu g/m^3$)	Blank ($\mu g/m^3$)
Calexico	13.7	0.24	0.06	1.15	8.22	0.64	2.42	0.41	0.5
El Centro	7.1	0.12	0.03	0.58	4.10	0.29	1.23	0.21	0.5
Brawley	7.0	0.10	0.03	0.59	4.07	0.26	1.25	0.21	0.5
In the absence of Mexico emissions									
Calexico	11.7	0.11	0.04	0.89	7.15	0.31	2.35	0.32	0.5
El Centro	6.6	0.07	0.02	0.50	3.92	0.23	1.22	0.18	0.5
Brawley	6.8	0.07	0.02	0.53	3.96	0.23	1.24	0.19	0.5

4.4 PRECURSOR SENSITIVITY ANALYSIS

To evaluate the impact of reducing emissions of different $PM_{2.5}$ precursors on the base year $PM_{2.5}$ DVs, a series of model sensitivity simulations were conducted, where emissions of the precursor species in Imperial County were reduced by 70% from the base year (2012) emissions. The 70% level was chosen as the high end of the recommended range of reductions by the U.S. EPA. Mexico emissions were included in the simulations, but were not reduced as part of the sensitivity analysis. Specifically, the effect of reductions in the following $PM_{2.5}$ precursors was investigated: direct $PM_{2.5}$ (or primary $PM_{2.5}$), nitrogen oxides (NO_x), sulfur oxides (SO_x), ammonia (NH_3), and volatile organic compounds (VOCs). For each precursor, only anthropogenic emissions in Imperial County were perturbed. Natural emissions and emissions outside of Imperial County (e.g., Mexico, other counties in California) were not changed.

Table 15 shows the change in base year DV at each site from a 70% reduction of controllable direct $PM_{2.5}$, NO_x, VOCs, SO_x, and NH_3 emissions. The DV change is calculated as the difference in the projected base year DV from the 70% reduction case minus the base year DV with Mexico emissions in Table 11. As shown in Table 15, direct $PM_{2.5}$ reductions had the largest impact on the DV, with all sites exhibiting a reduction in DV greater than 1.8 $\mu g/m^3$. All other precursors exhibited a much smaller response, with the largest change being a 0.06 $\mu g/m^3$ decrease in DV at the Brawley monitors due to NO_x reductions. U.S. EPA precursor sensitivity guidance defines a precursor to be insignificant if the annual DV change is less than 0.2 $\mu g/m^3$ when that precursor is reduced by 30-70%. Based on this definition, all $PM_{2.5}$ precursors are considered insignificant.

Given that a 70% perturbation in the emissions could be considered excessive, an additional sensitivity simulation for direct $PM_{2.5}$ was conducted, where emissions were reduced by 30%. When direct $PM_{2.5}$ emissions in Imperial County were reduced by 30%, the DV was reduced by 1.1 µg/m^3, 1.0 µg/m^3, and 0.8 µg/m^3 at the Calexico, El Centro, and Brawley monitors, respectively. Therefore, even with a much smaller 30% reduction, direct $PM_{2.5}$ is still deemed as not insignificant.

Table 15. Change of base year (2012) DV at sites in Imperial County due to county wide 70% reduction of anthropogenic precursors. Numbers in shaded rows are the reduction of DVs (µg/m^3) due to precursor reductions respectively.*

Site	DV2012 (µg/m^3)	DV2012 (µg/m^3) with 70% reduction of anthropogenic precursor				
		$PM_{2.5}$	NOx	ROG	SOx	NH_3
Calexico	14.23	11.55	14.18	14.2	14.23	14.22
		-2.68	-0.05	-0.03	0	-0.01
El Centro	7.26	4.94	7.24	7.24	7.26	7.26
		-2.32	-0.02	-0.02	0	0
Brawley	7.38	5.53	7.32	7.36	7.38	7.37
		-1.85	-0.06	-0.02	0	-0.01

* To highlight the differences, 2 decimal points in the DV are shown, rather than the single decimal point required by the SIP guidance.

4.5 UNMONITORED AREA ANALYSIS

The unmonitored area analysis is used to ensure that there are no regions outside of the existing monitoring network that would exceed the NAAQS if a monitor was present (U.S. EPA, 2014). U.S. EPA recommends combining spatially interpolated DV fields with modeled PM2.5 gradients to generate gridded future year gradient adjusted DVs.

This analysis can be done using the Model Attainment Test Software (MATS) (Abt, 2014). However, this software is not open source and comes as a precompiled software package. To maintain transparency and flexibility in the analysis, in-house R codes (https://www.r-project.org/) developed at CARB, were utilized in this analysis.

The unmonitored area analysis was conducted using the annual $PM_{2.5}$ DVs from all the available sites that fall within the 4 km inner modeling domain along with the future year

2021 4km CMAQ model outputs. The steps followed in the unmonitored area analysis are as follows:

> **Step 1**: At each grid cell, the annual averaged $PM_{2.5}$ species NO_3^-, SO_4^{2-}, OC, EC, Salt, and Dust were calculated based on model outputs. The gradient of each species between each grid cell and grid cells which contain a monitor was calculated.
>
> **Step 2**: The spatially interpolated field of each $PM_{2.5}$ species was generated based on the future year annual averaged species at each monitor, which were calculated based on base year species concentration and quarterly RRF values. The interpolation is done using normalized inverse distance squared weightings for all monitors within a grid cell's Voronoi Region (calculated with the R tripack library; https://cran.r-project.org/web/packages/tripack/README), and adjusted based on the gradients between the grid cell and the corresponding monitor from Step 1.
>
> **Step 3**: At each grid cell, DV was calculated with the summation of all species and blank mass (0.5 µg/m^3), where NH_4^+ and water were calculated based on ion balance.
>
> **Step 4**: The future-year gridded annual $PM_{2.5}$ DVs (from Step 3) were examined to determine if there are any peak values higher than those at the monitors, which could potentially cause violations of the applicable annual $PM_{2.5}$ NAAQS.

Figure 18 shows the spatial distribution of gridded annual $PM_{2.5}$ DVs in 2021 for Imperial County, in the absence of Mexico anthropogenic emissions, based on the unmonitored area analysis (described above). The maroon colored stars denote the $PM_{2.5}$ monitoring sites used in the analysis. The lower right corner of Imperial County, shown in light blue color in Figure 18, is outside the modeling domain and is not part of the non-attainment region, so that region was not included in the analysis. The red spot in the middle of county is where the Navy Air Facility El Centro located, which represents a constant uncontrollable and uncategorized emission source. The unmonitored area analysis predicts that all unmonitored regions within Imperial County would attain the 12 µg/m^3 annual $PM_{2.5}$ standard by 2021 in the absence of Mexico emissions.

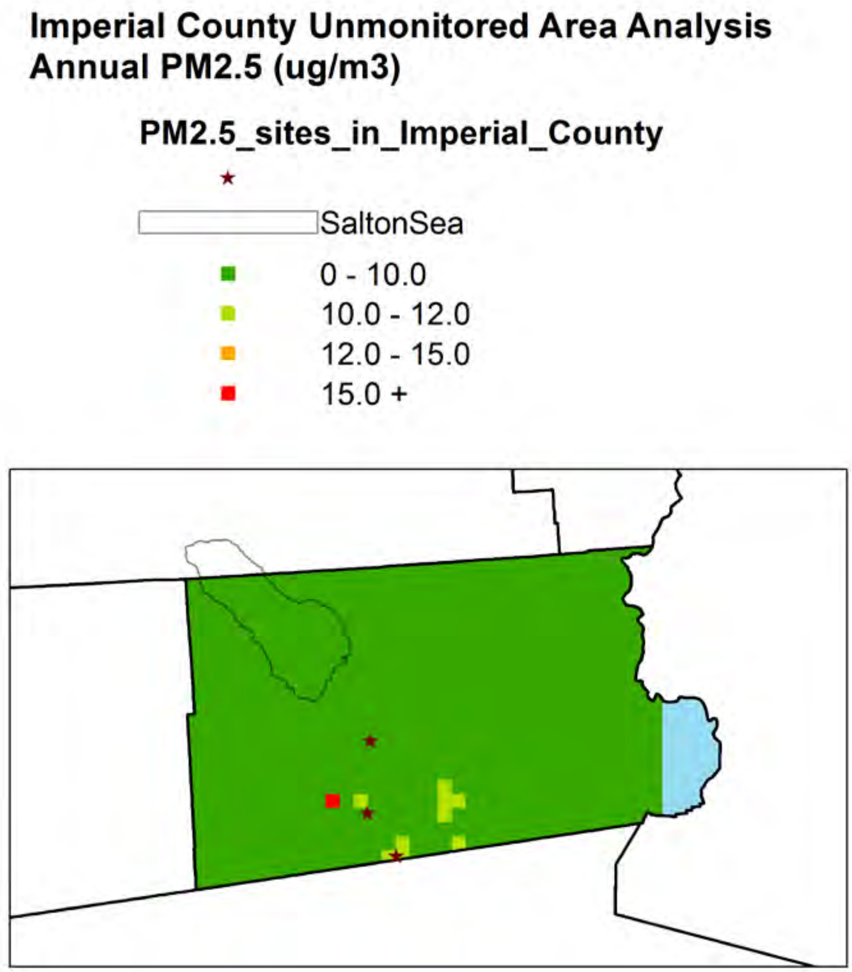

Figure 18. Spatial distribution of year 2021 annual $PM_{2.5}$ DVs based on the unmonitored area analysis in Imperial County.

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SUPPLEMENTAL MATERIALS

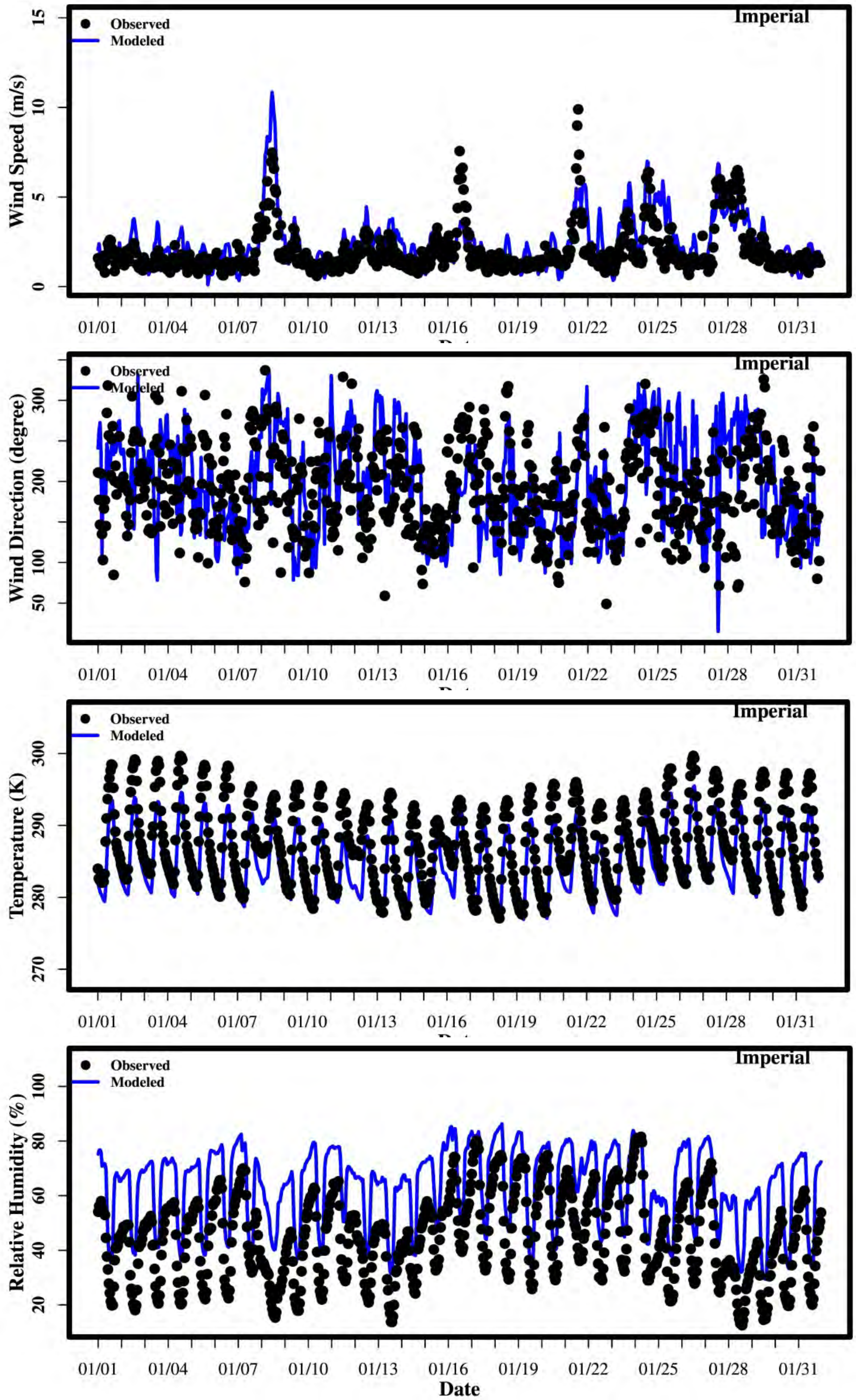

Figure S. 1 Time series of wind speed, direction, temperature and relative humidity for Imperial County in January 2012.

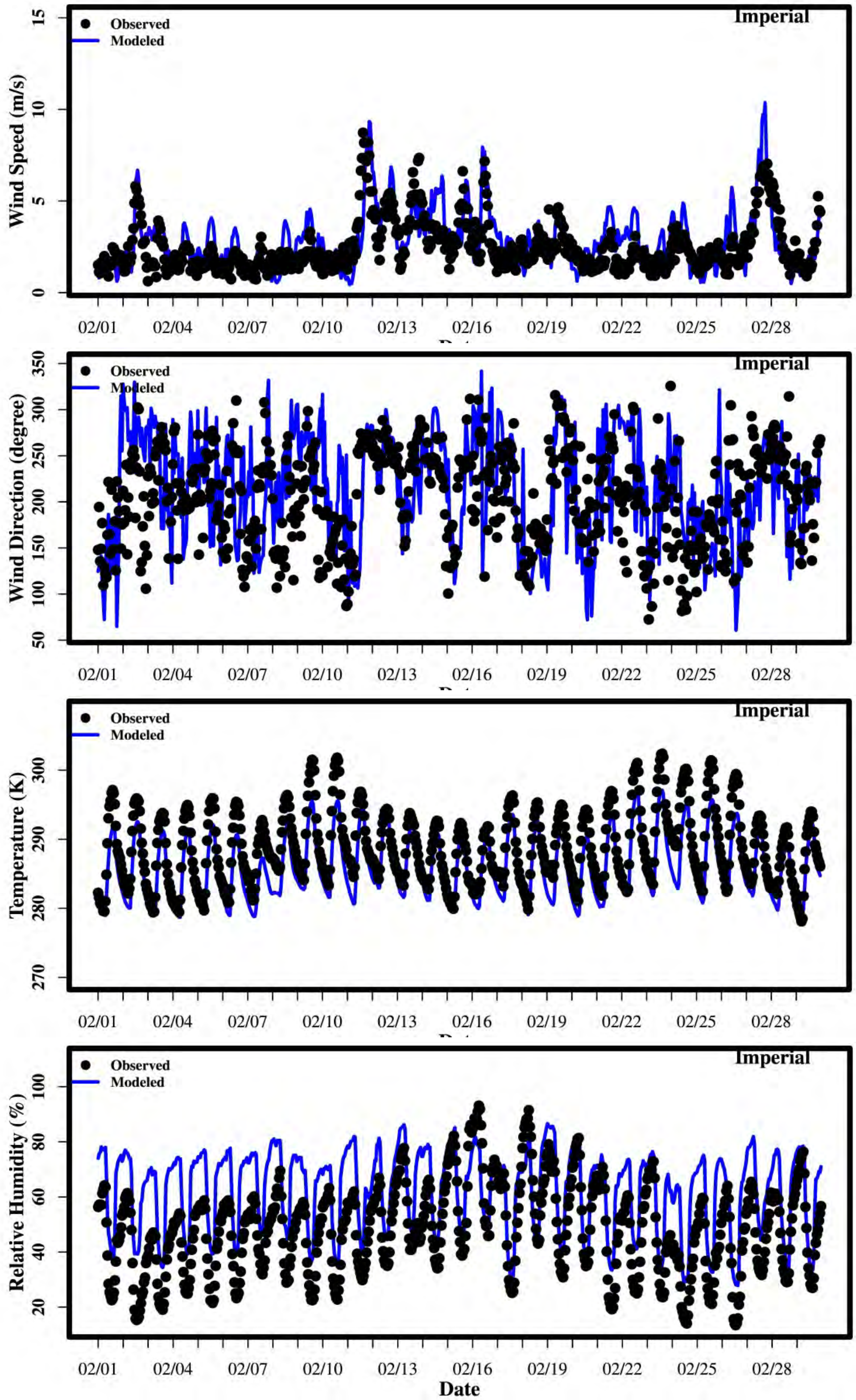

Figure S. 2 Time series of wind speed, direction, temperature and relative humidity for Imperial County in February 2012.

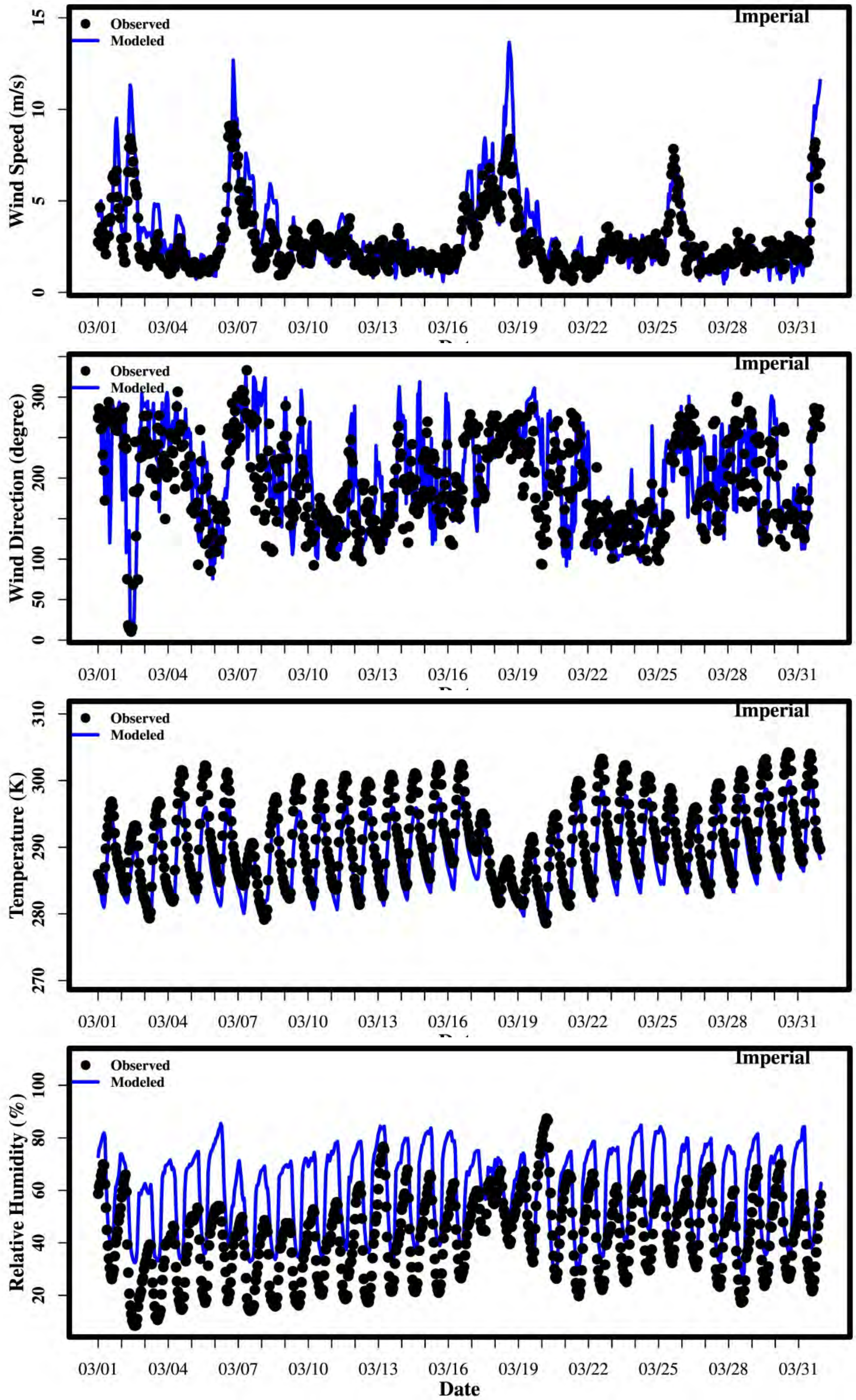

Figure S. 3 Time series of wind speed, direction, temperature and relative humidity for Imperial County in March 2012.

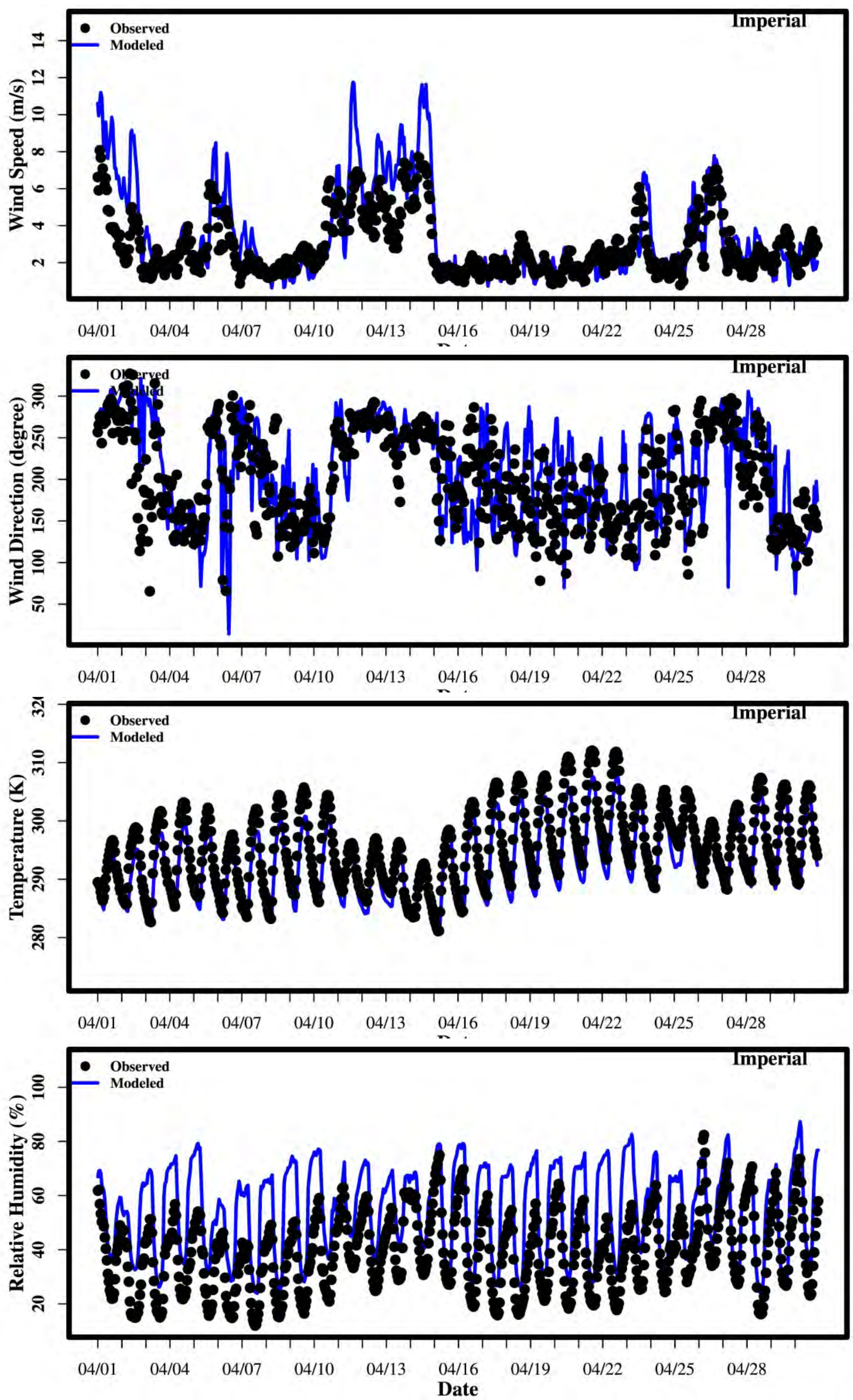

Figure S. 4 Time series of wind speed, direction, temperature and relative humidity for Imperial County in April 2012.

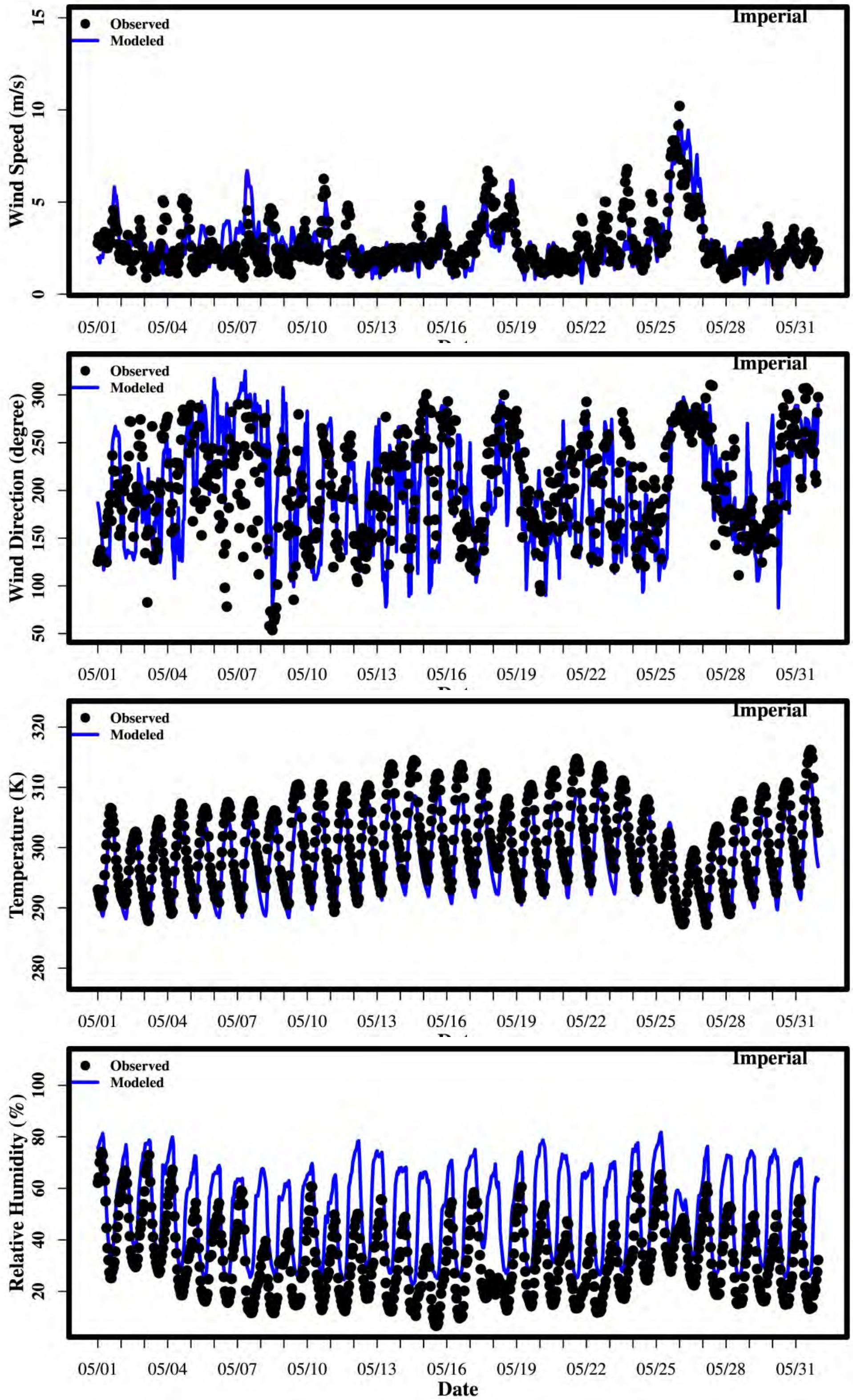

Figure S. 5 Time series of wind speed, direction, temperature and relative humidity for Imperial County in May 2012.

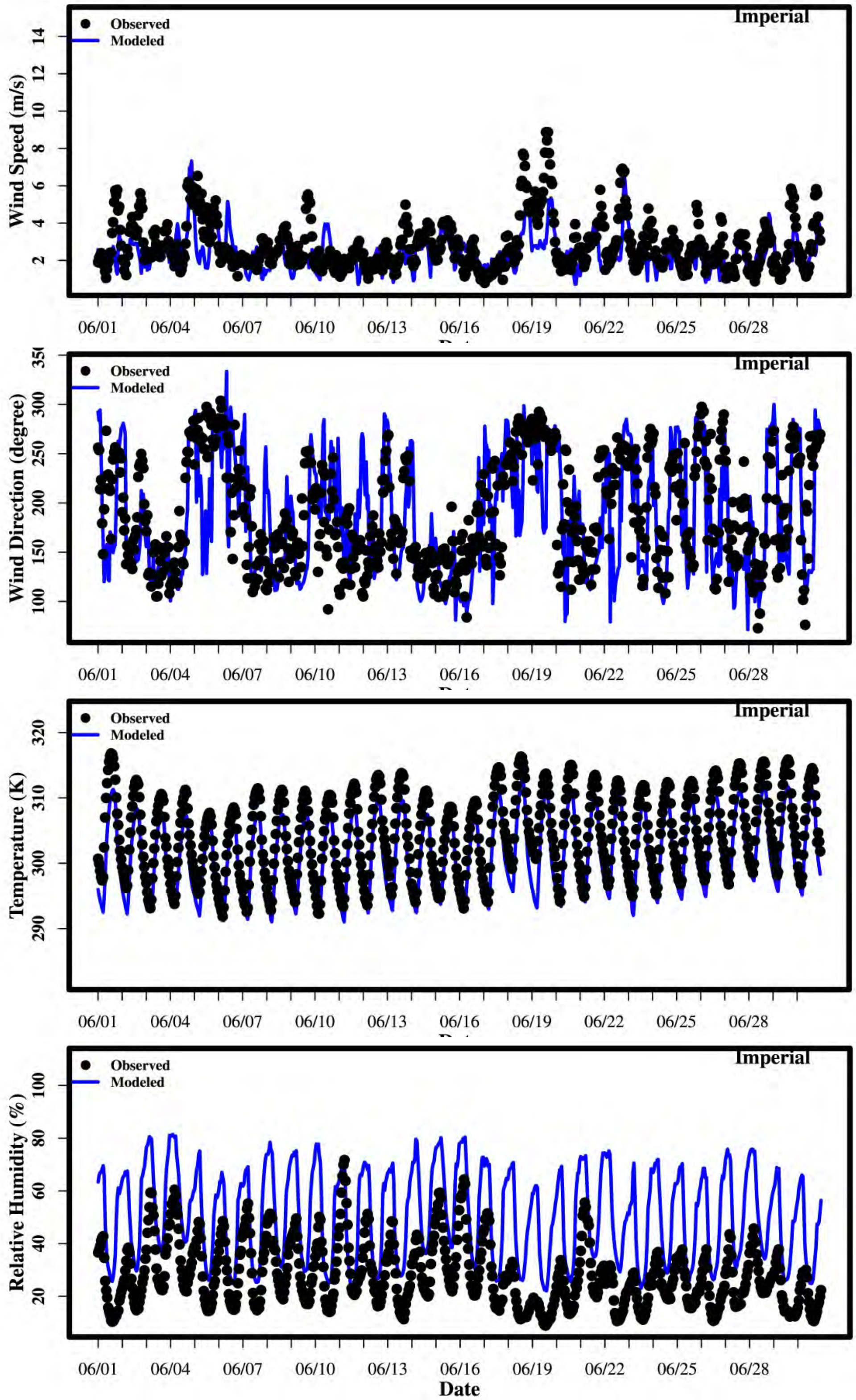

Figure S. 6 Time series of wind speed, direction, temperature and relative humidity for Imperial County in June 2012.

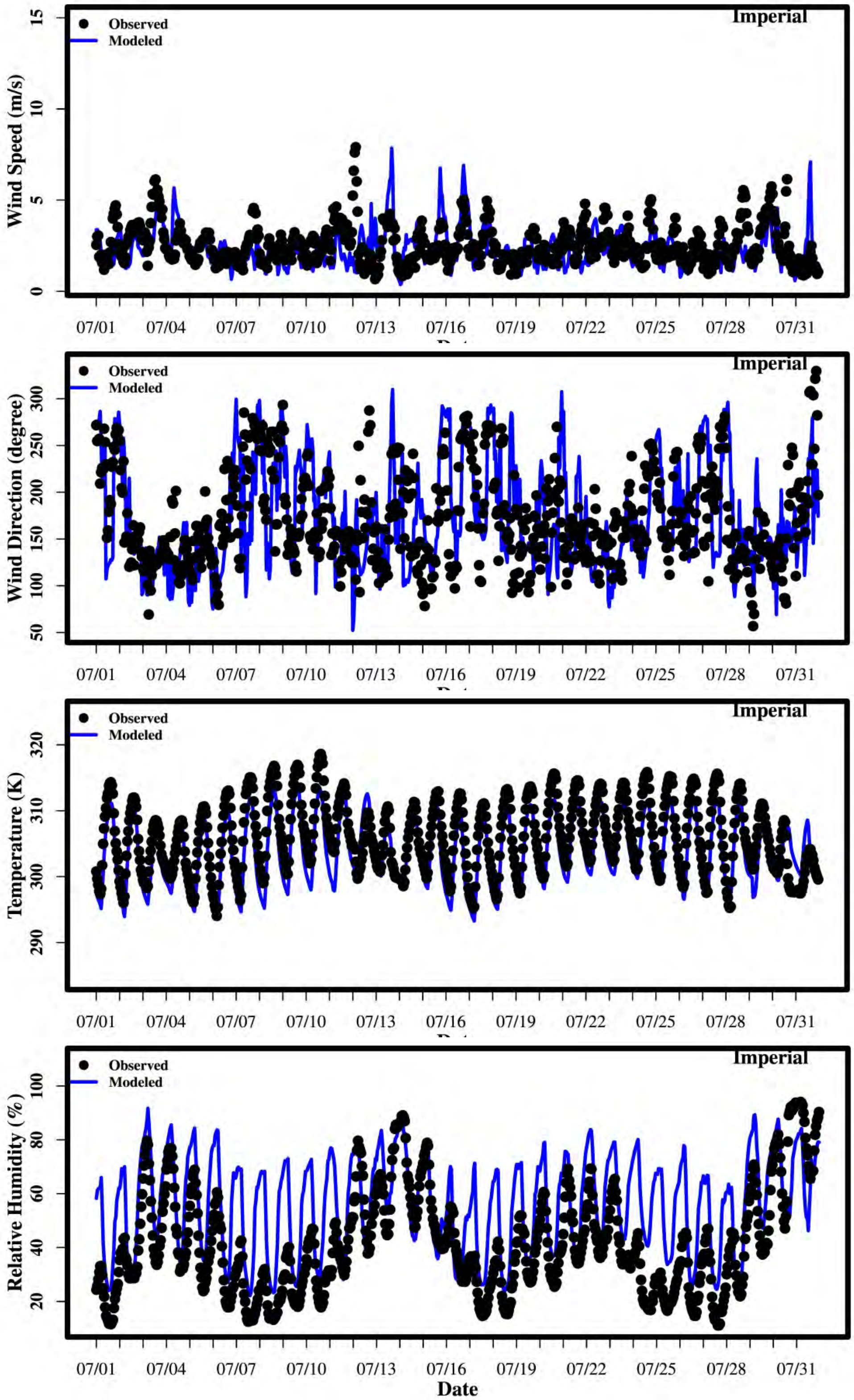

Figure S. 7 Time series of wind speed, direction, temperature and relative humidity for Imperial County in July 2012.

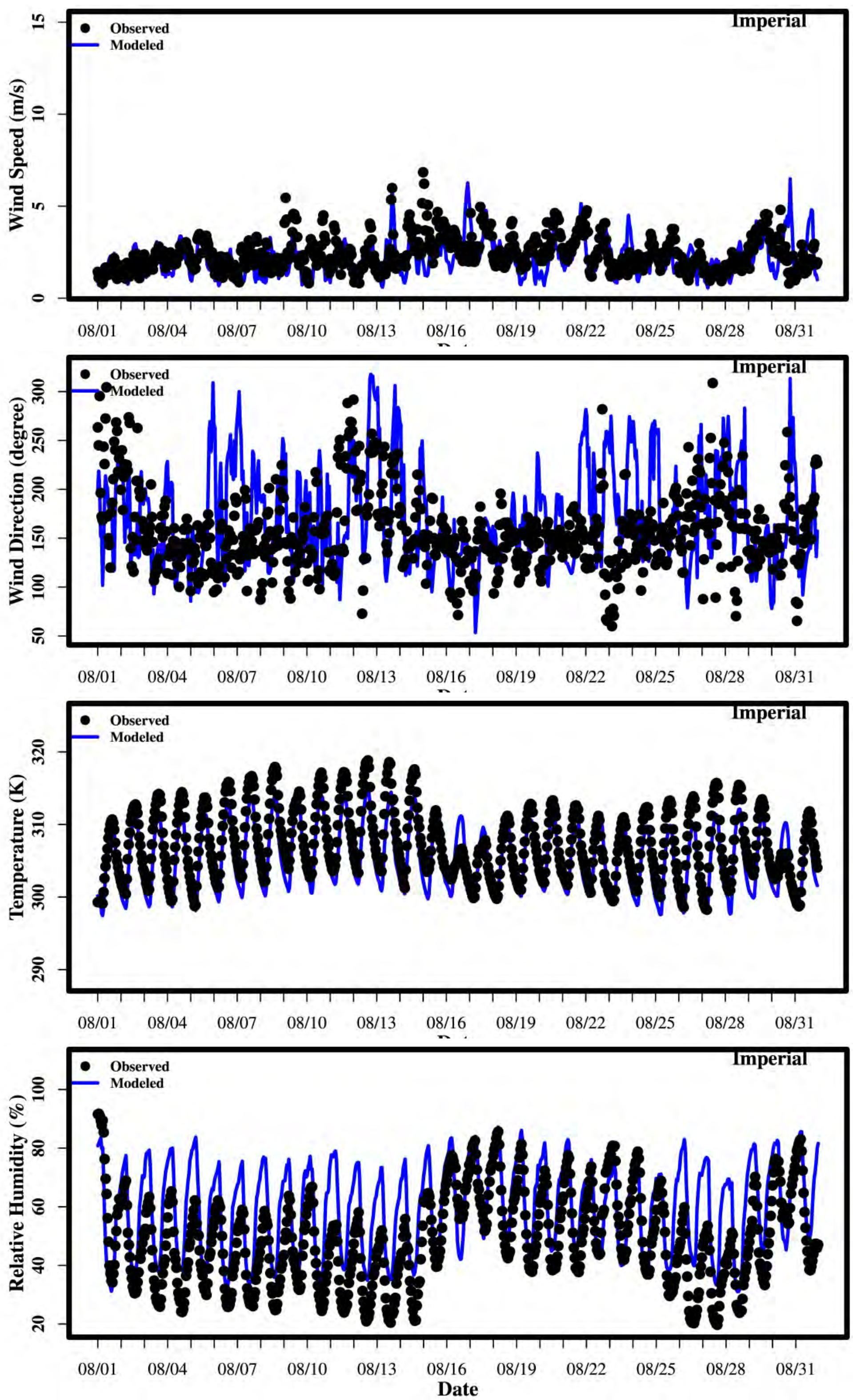

Figure S. 8 Time series of wind speed, direction, temperature and relative humidity for Imperial County in August 2012.

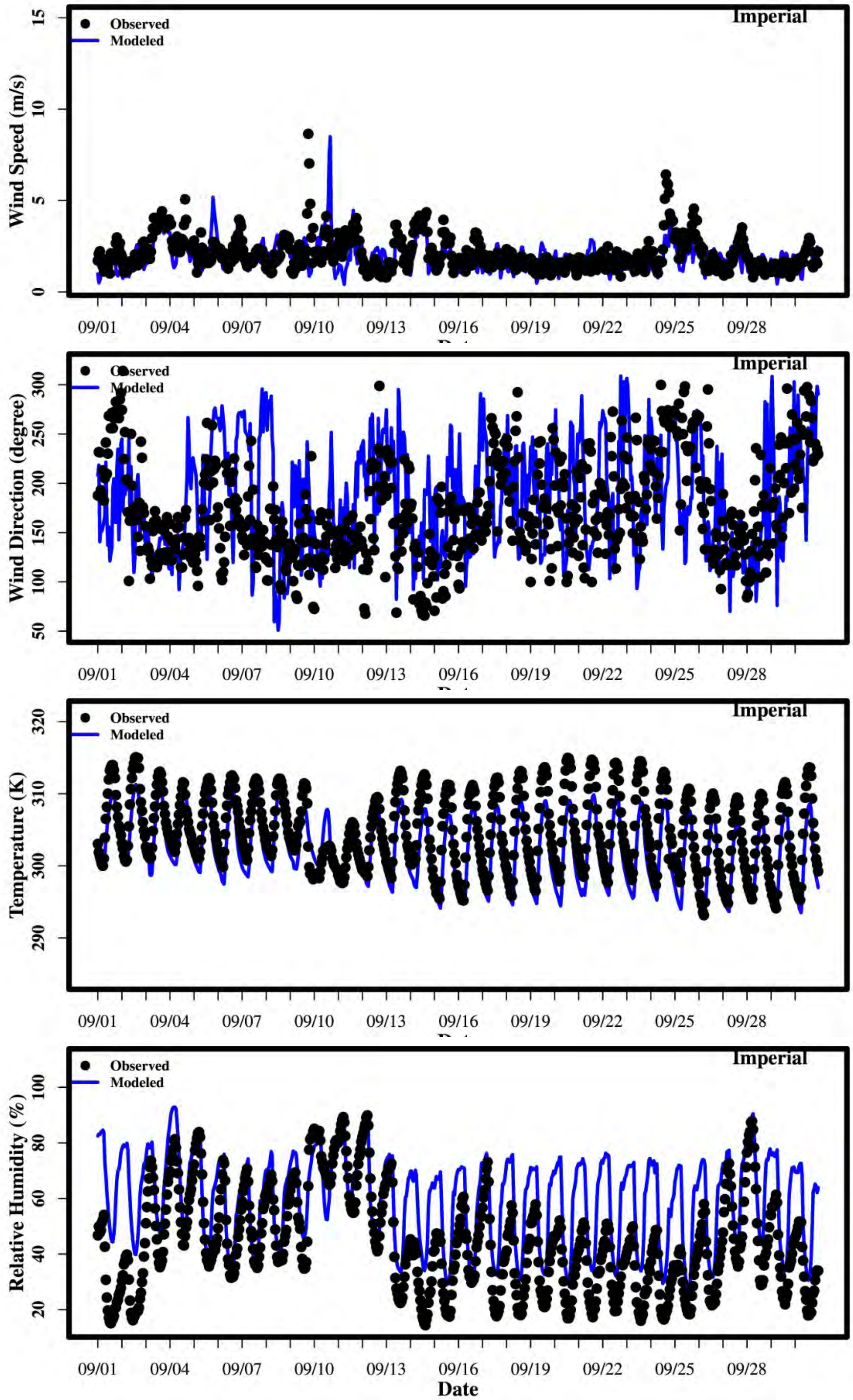

Figure S. 9 Time series of wind speed, direction, temperature and relative humidity for Imperial County in September 2012.

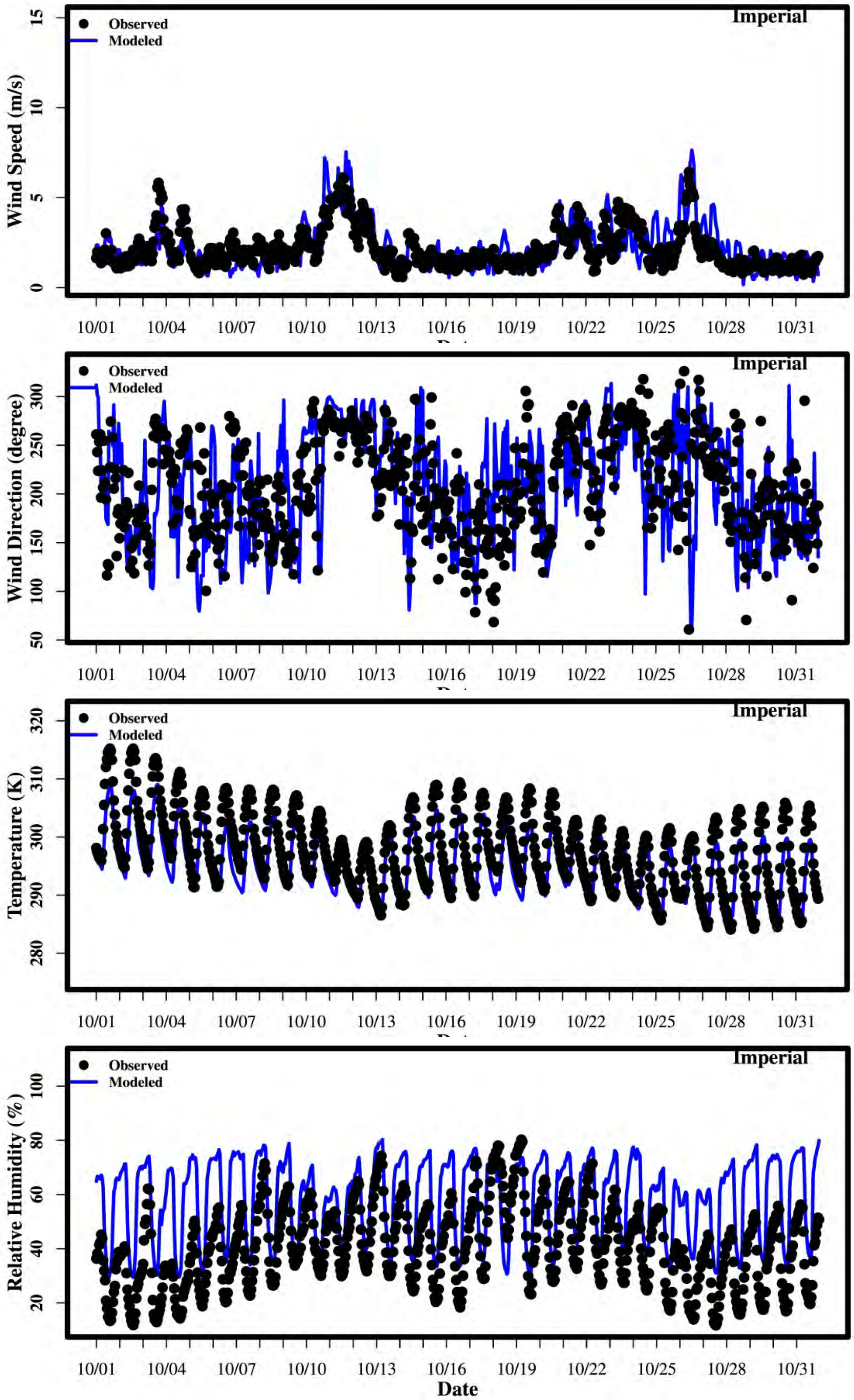

Figure S. 10 Time series of wind speed, direction, temperature and relative humidity for Imperial County in October 2012.

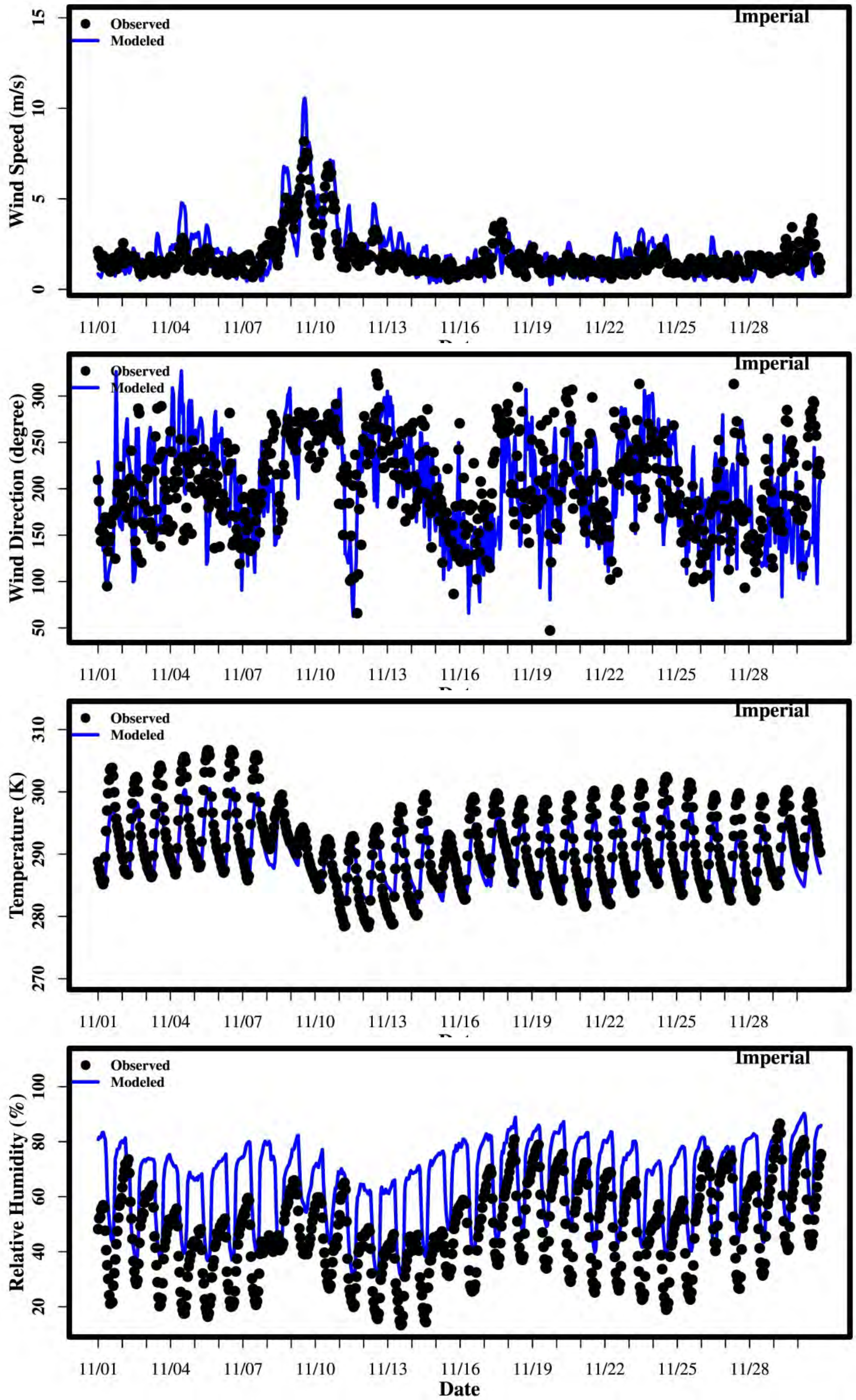

Figure S. 11 Time series of wind speed, direction, temperature and relative humidity for Imperial County in November 2012.

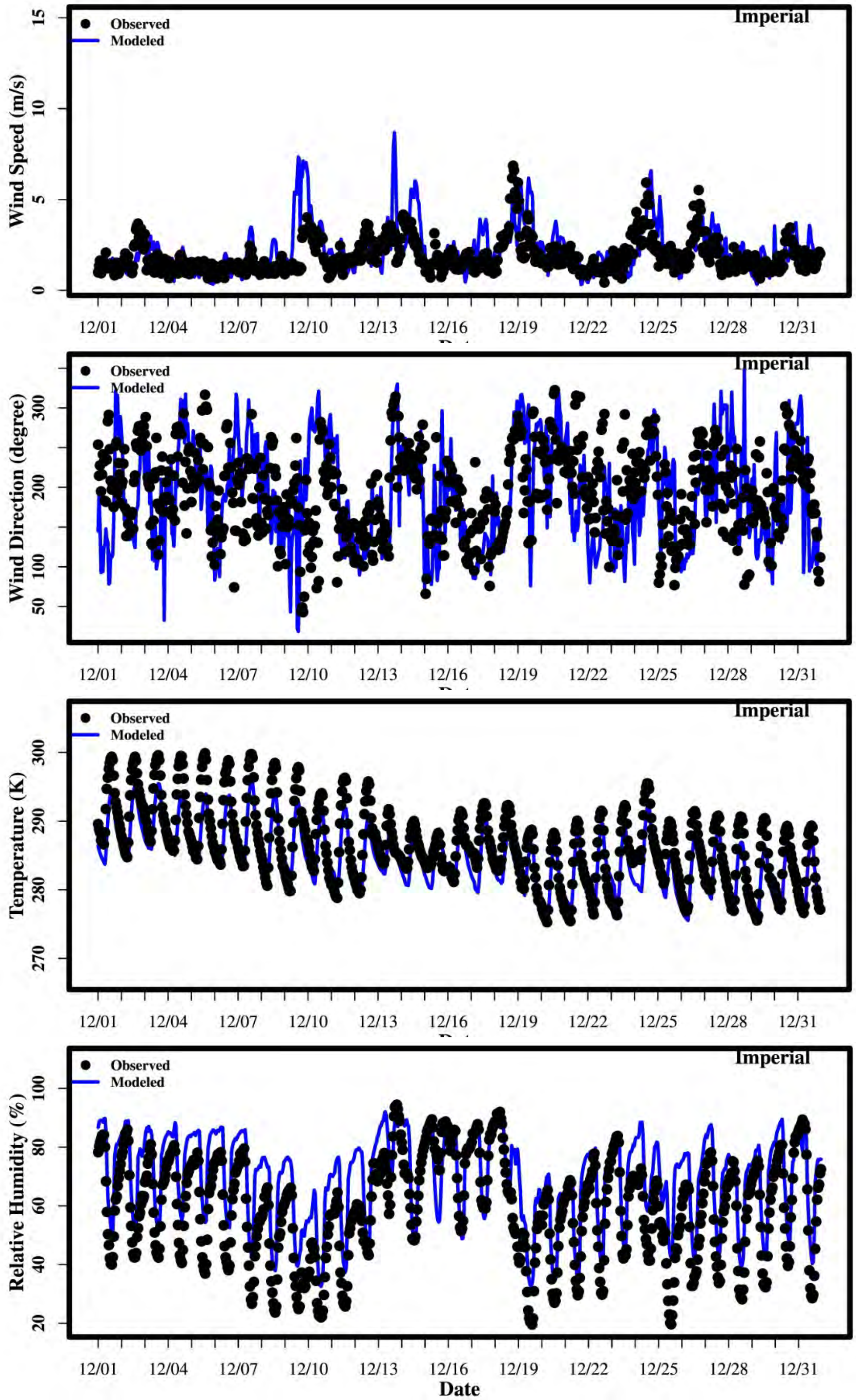

Figure S. 12 Time series of wind speed, direction, temperature and relative humidity for Imperial County in December 2012.

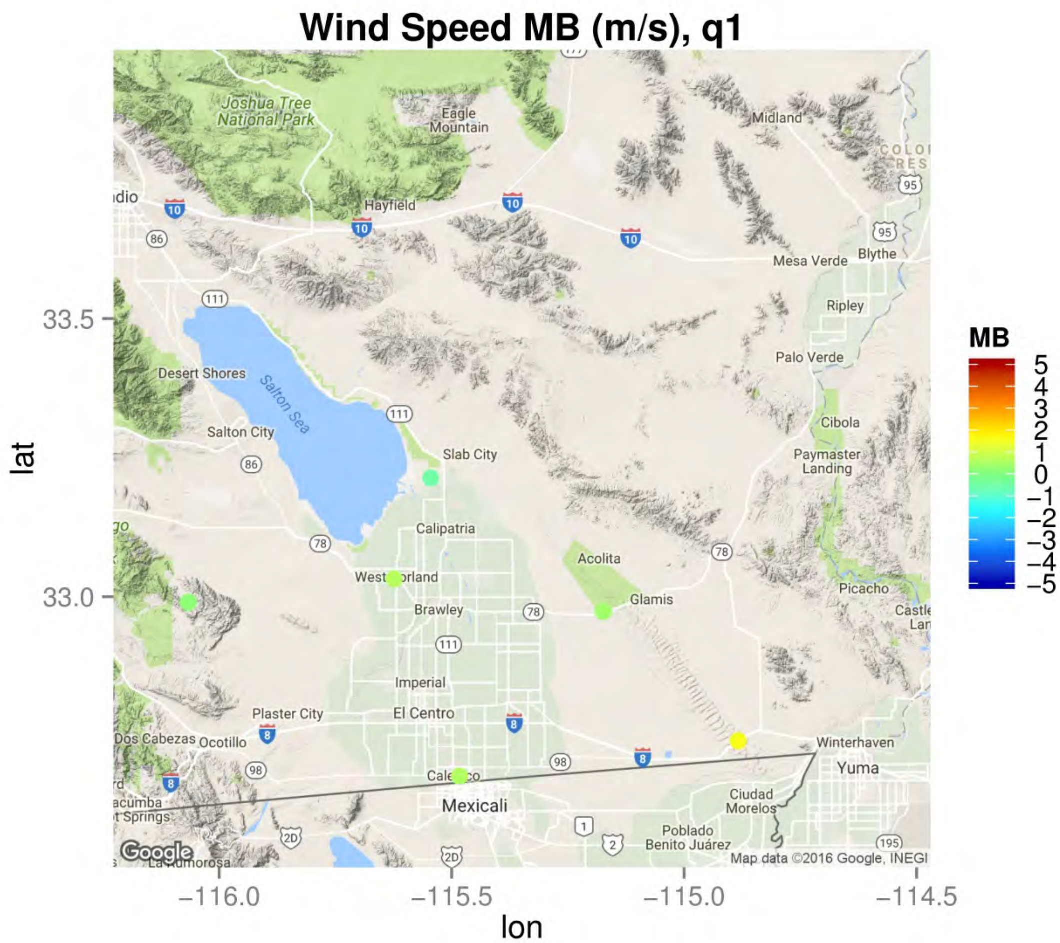

Figure S. 13 Wind speed mean bias in the first quarter of 2012

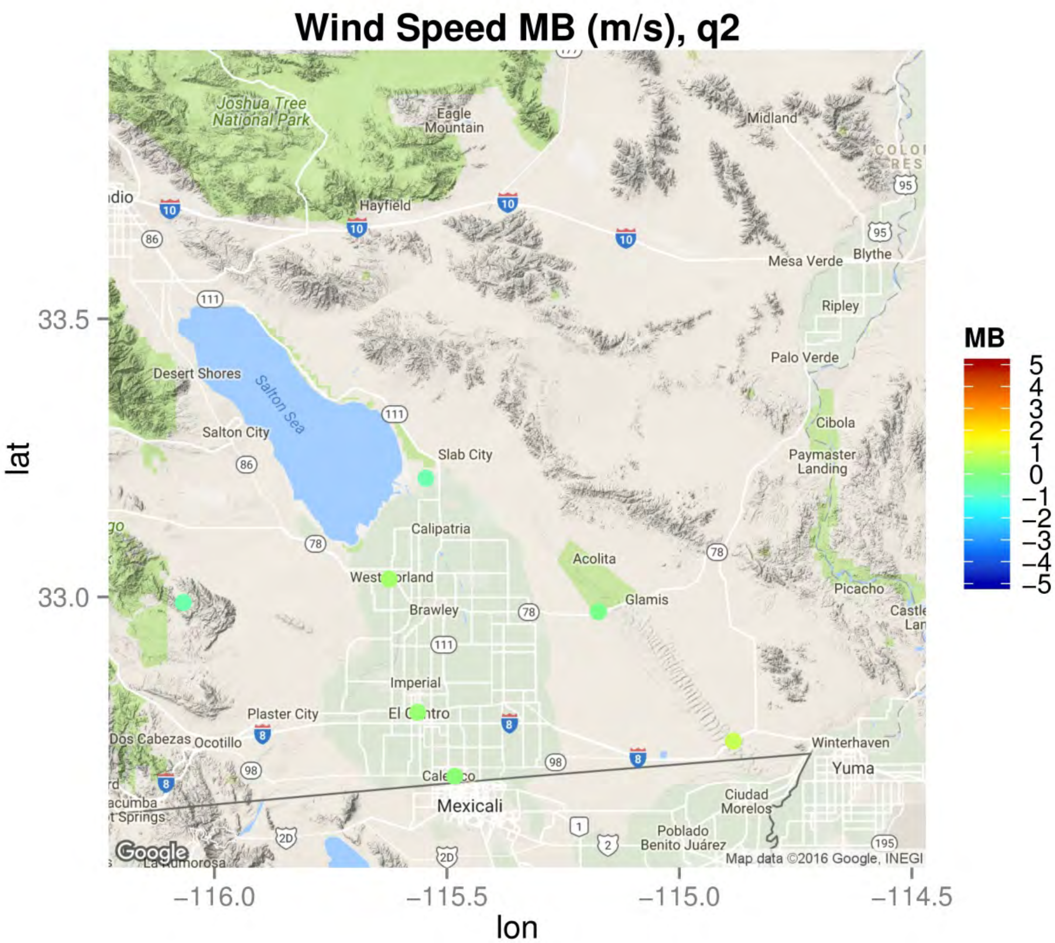

Figure S. 14 Wind speed mean bias in the second quarter of 2012

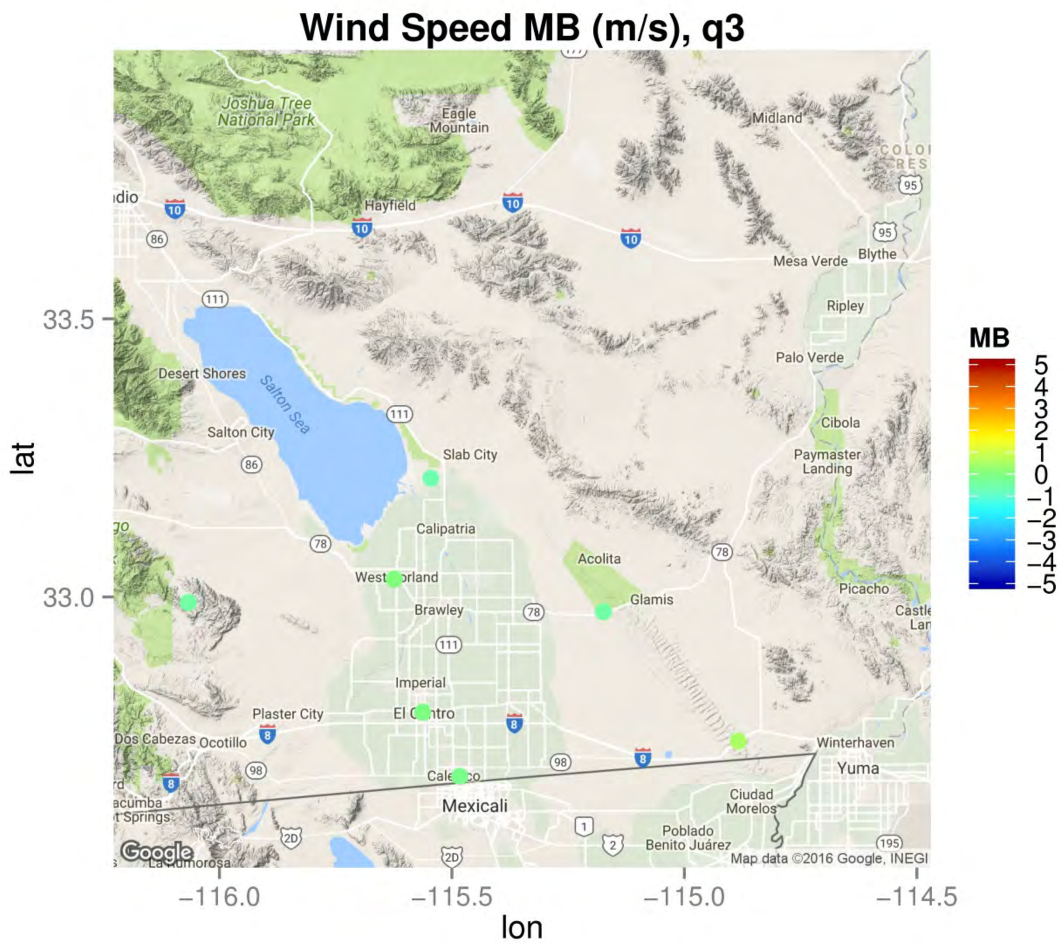

Figure S. 15 Wind speed mean bias in the third quarter of 2012

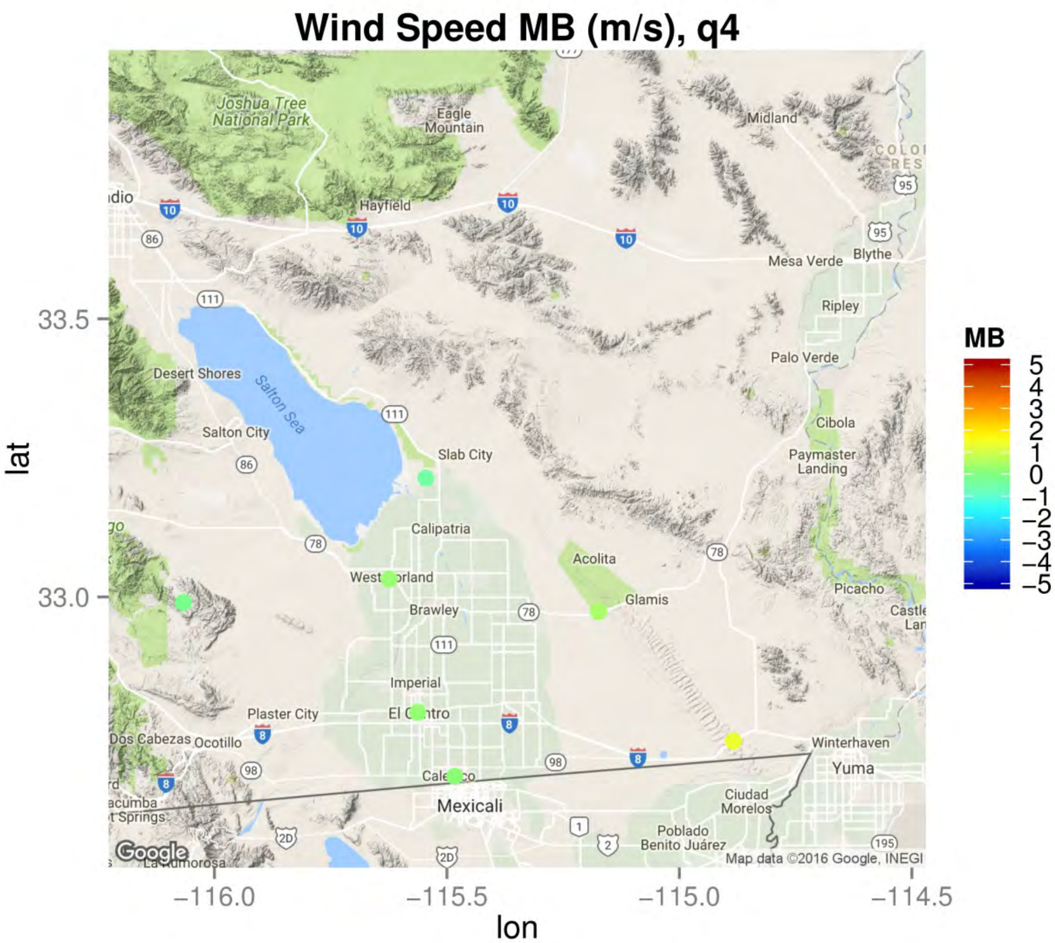

Figure S. 16 Wind speed mean bias in the fourth quarter of 2012

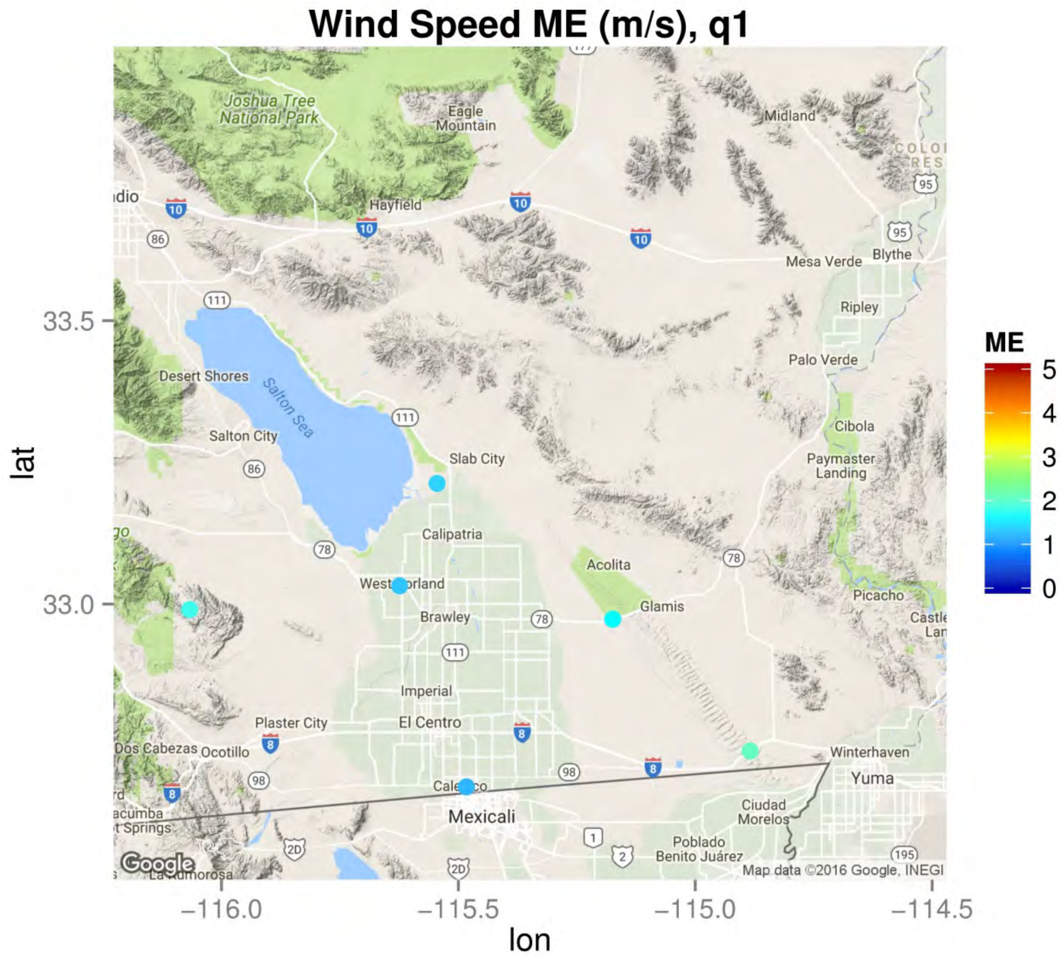

Figure S. 17 Wind speed mean error in the first quarter of 2012

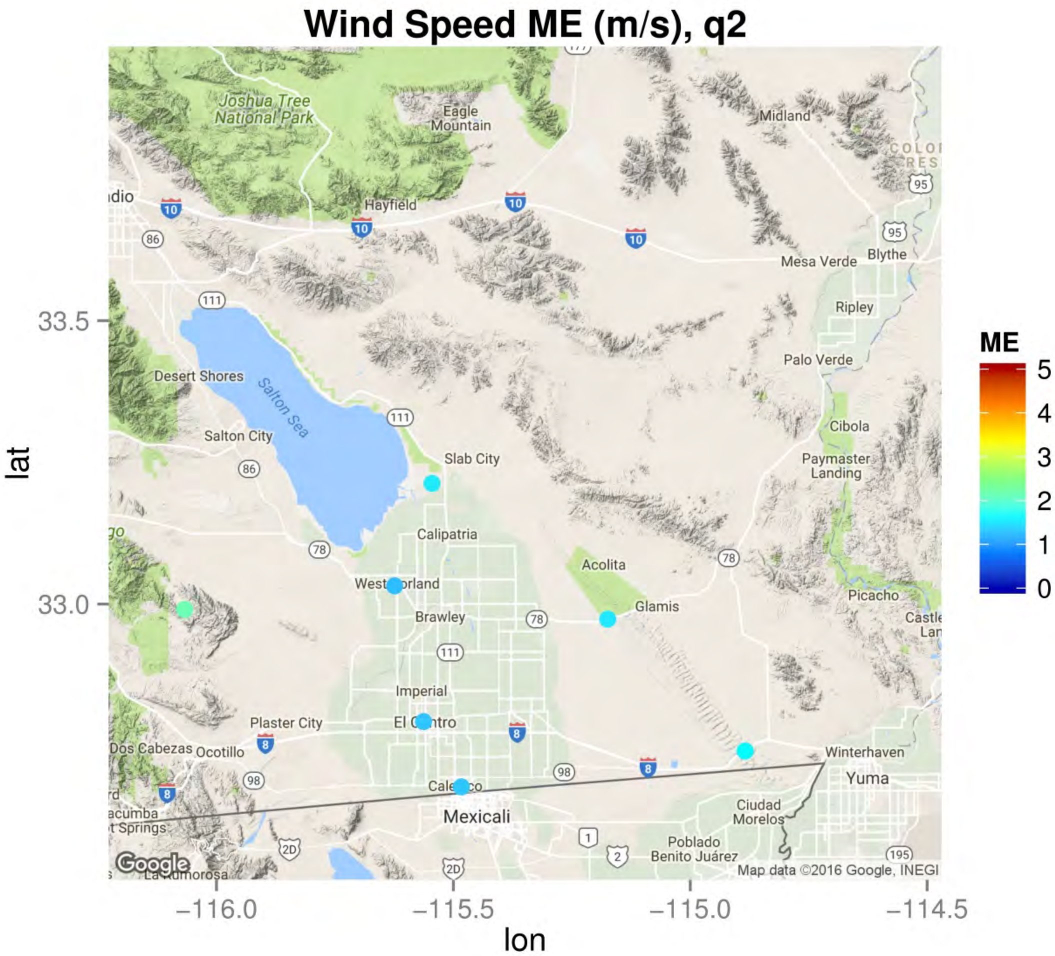

Figure S. 18 Wind speed mean error in the second quarter of 2012

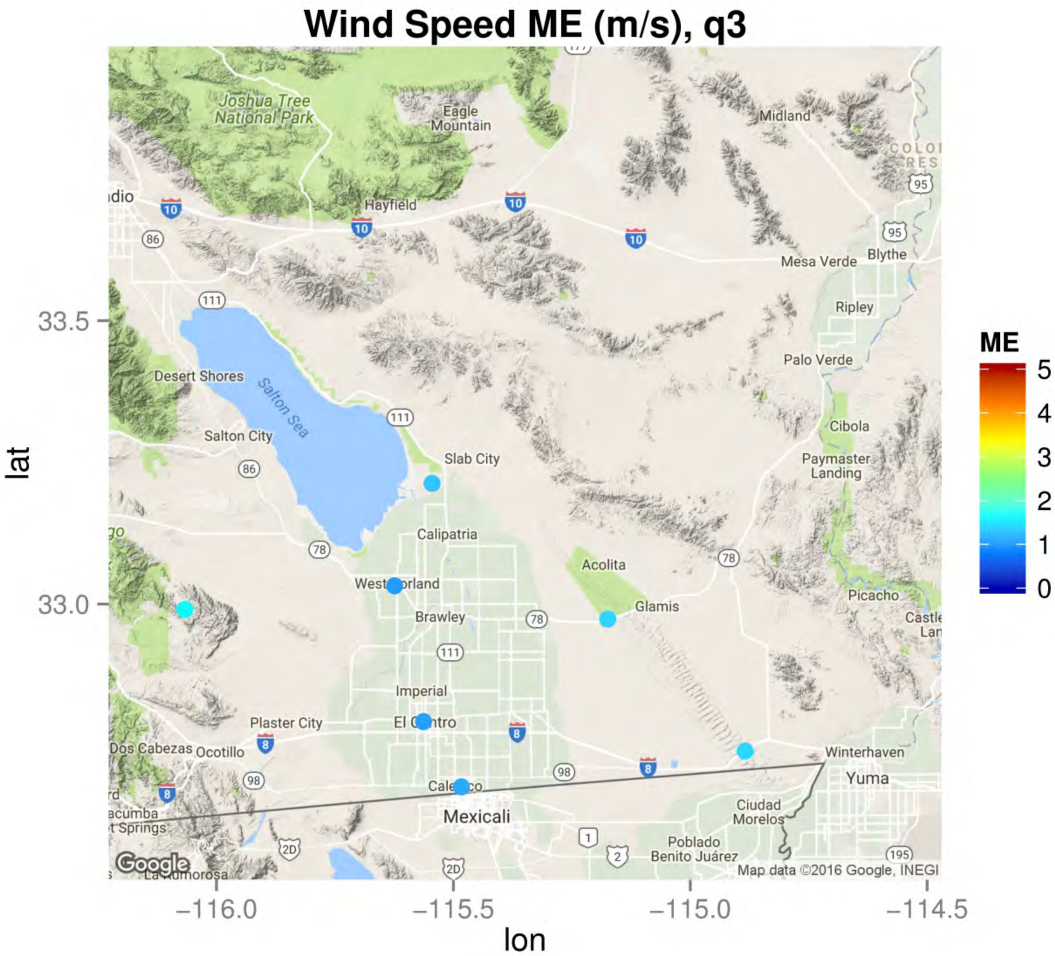

Figure S. 19 Wind speed mean error in the third quarter of 2012

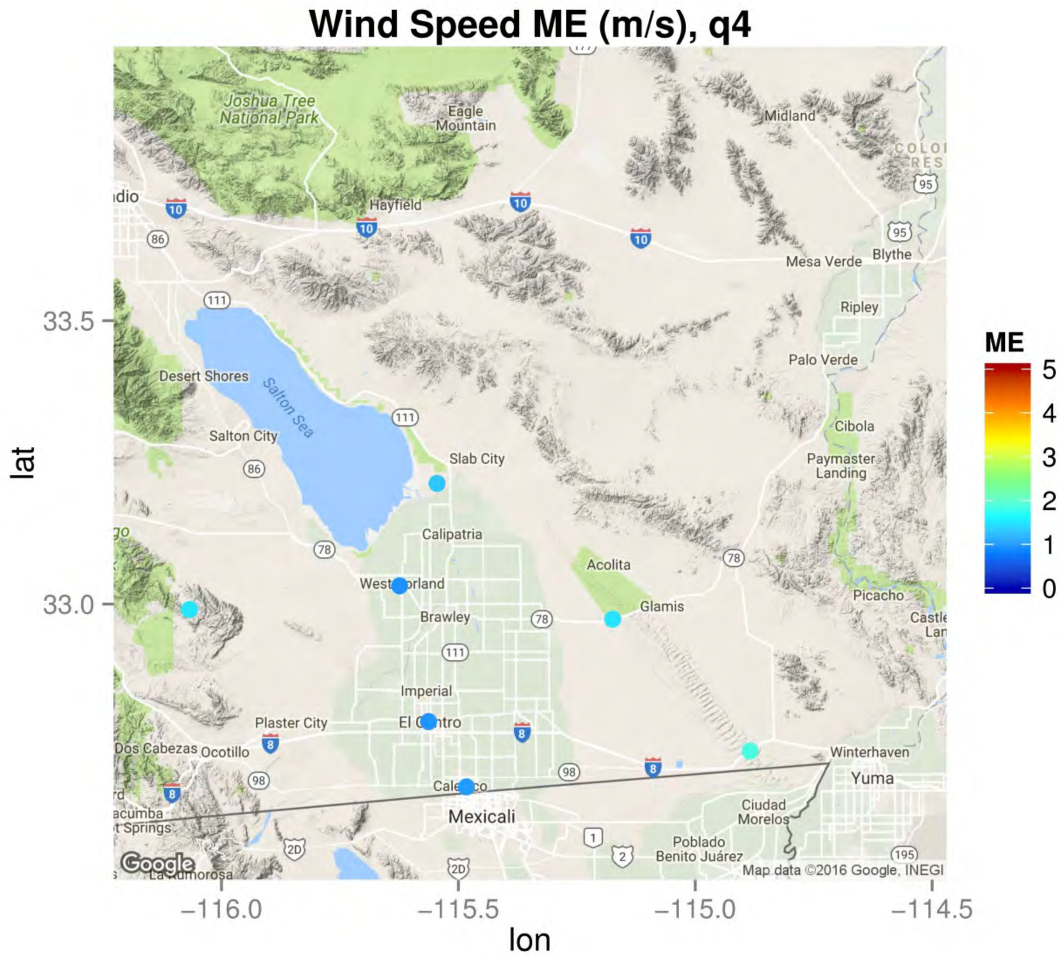

Figure S. 20 Wind speed mean error in the fourth quarter of 2012

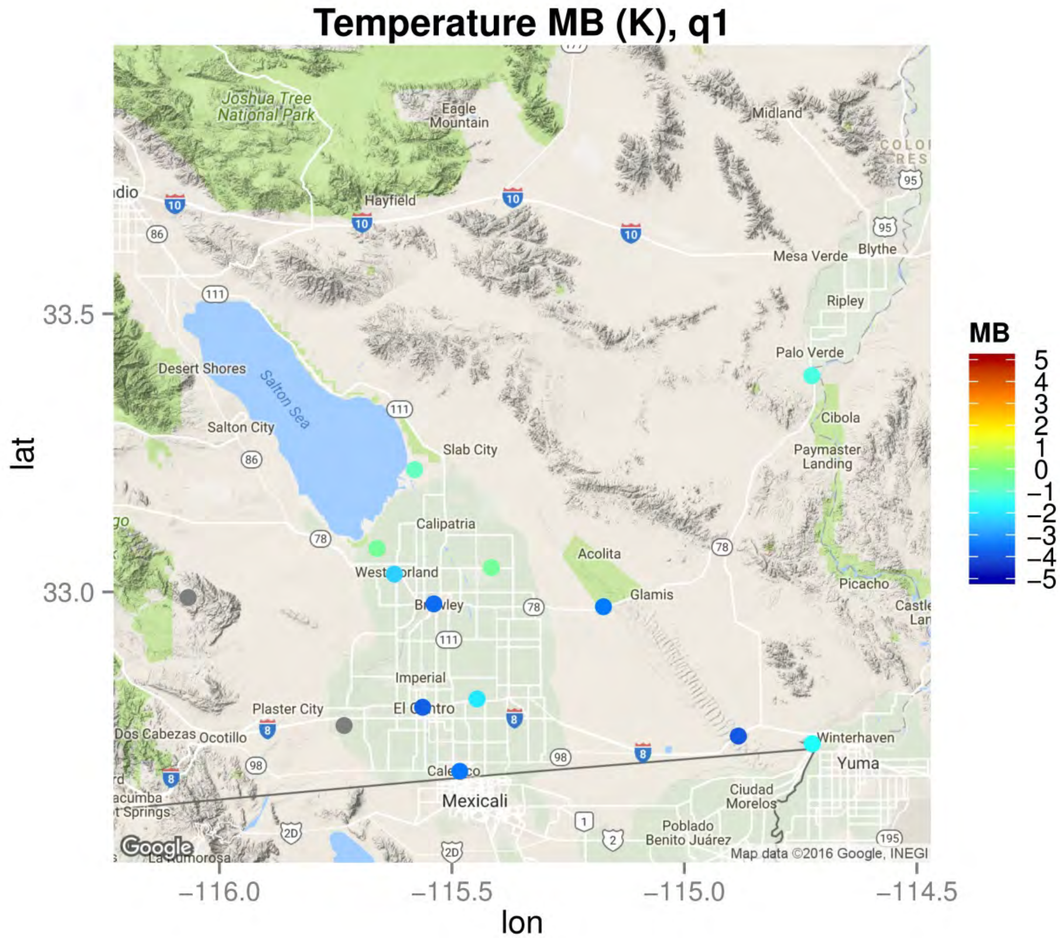

Figure S. 21 Temperature mean bias in the first quarter of 2012

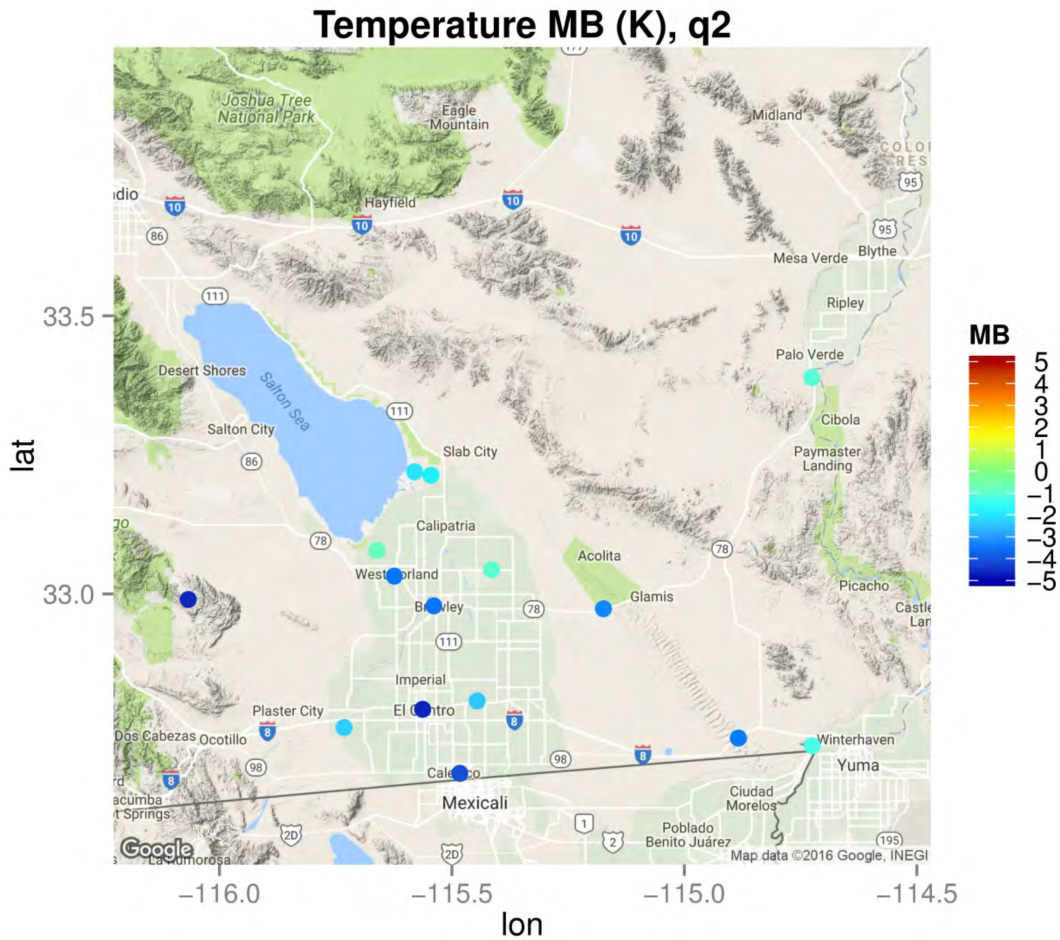

Figure S. 22 Temperature mean bias in the second quarter of 2012

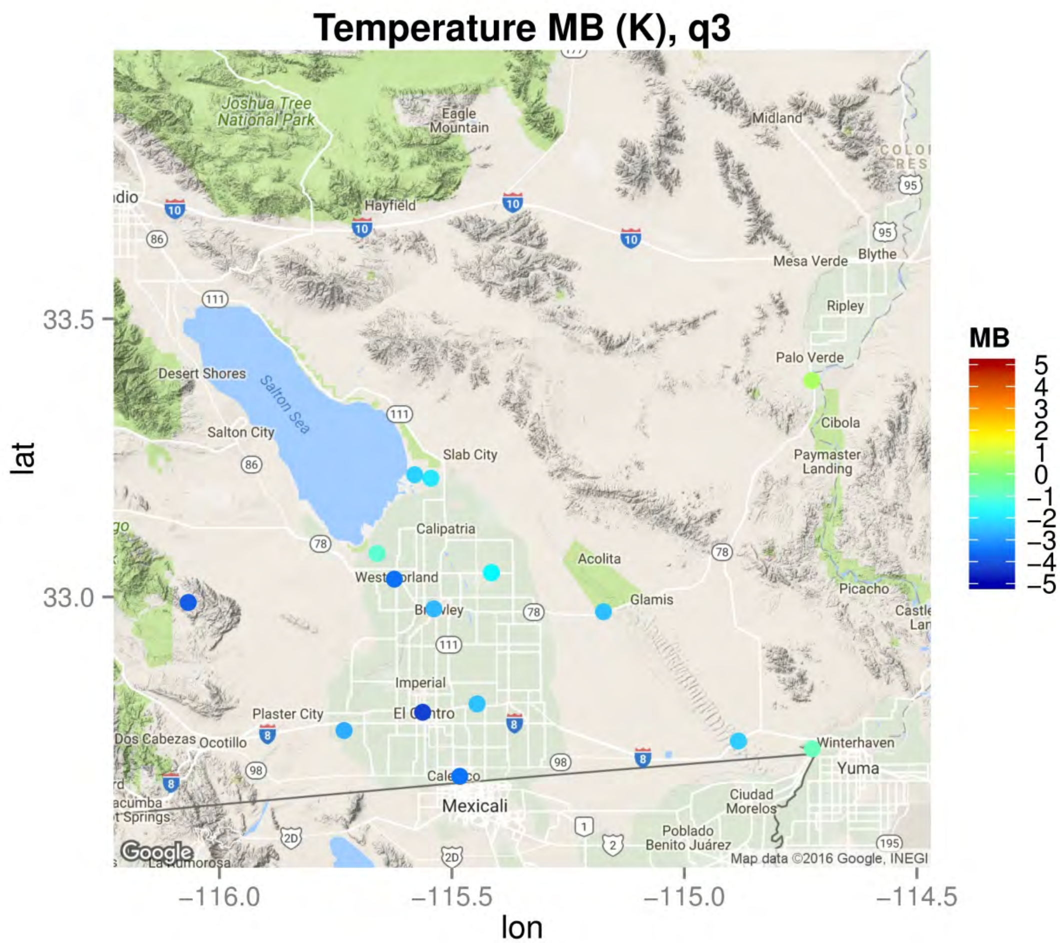

Figure S. 23 Temperature mean bias in the third quarter of 2012

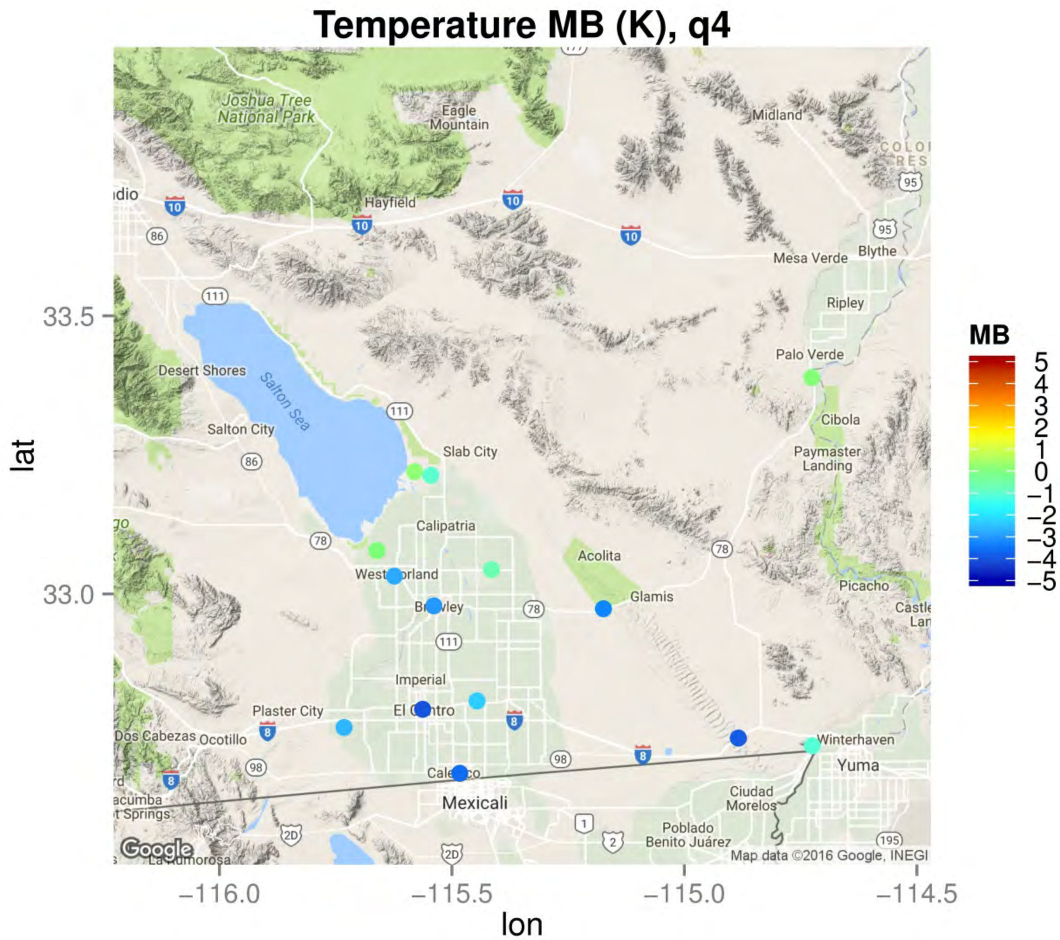

Figure S. 24 Temperature mean bias in the fourth quarter of 2012

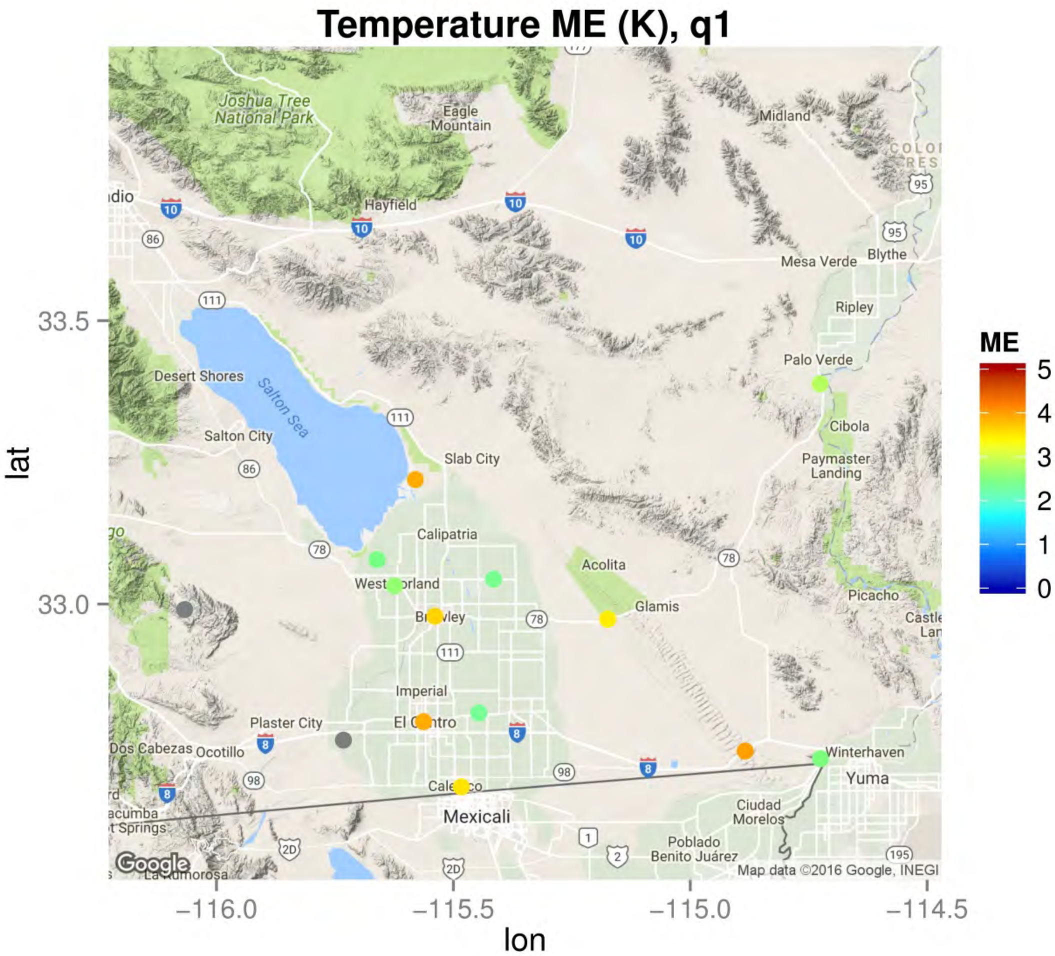

Figure S. 25 Temperature mean error in the first quarter of 2012

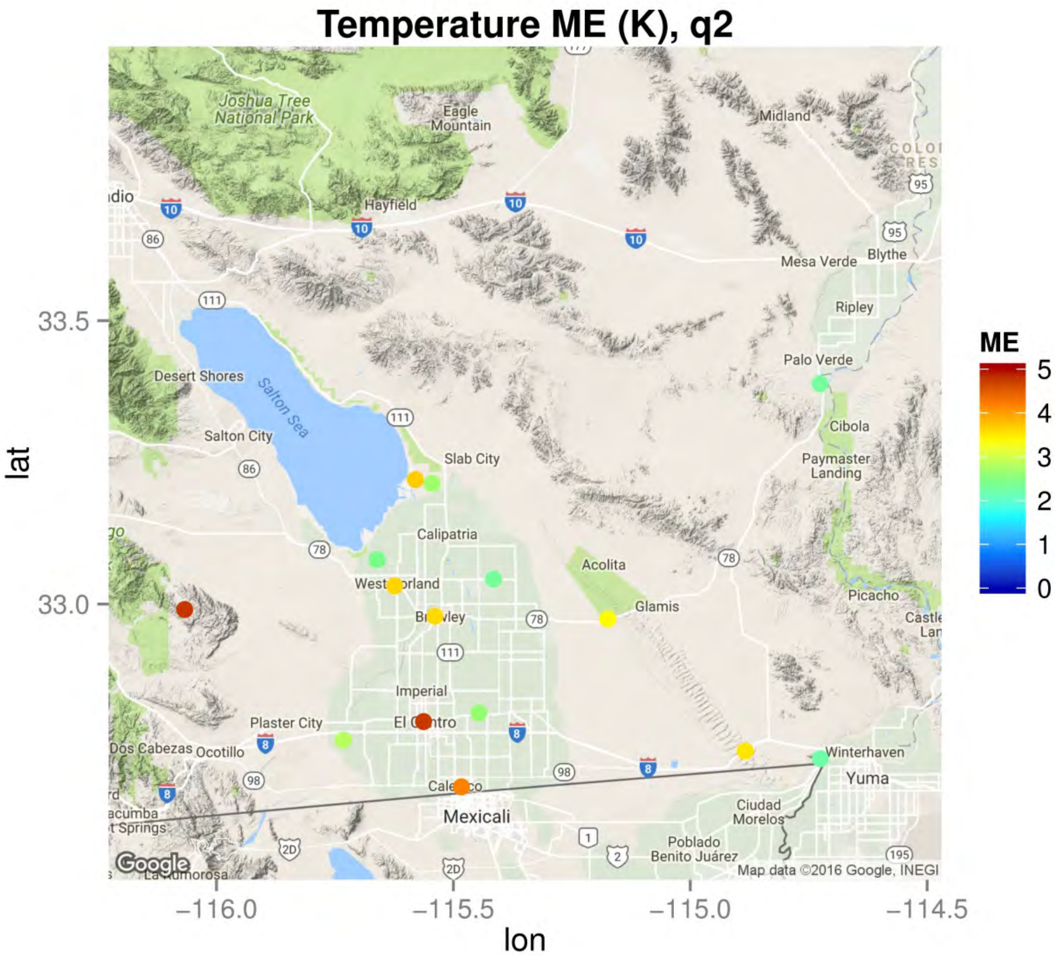

Figure S. 26 Temperature mean error in the second quarter of 2012

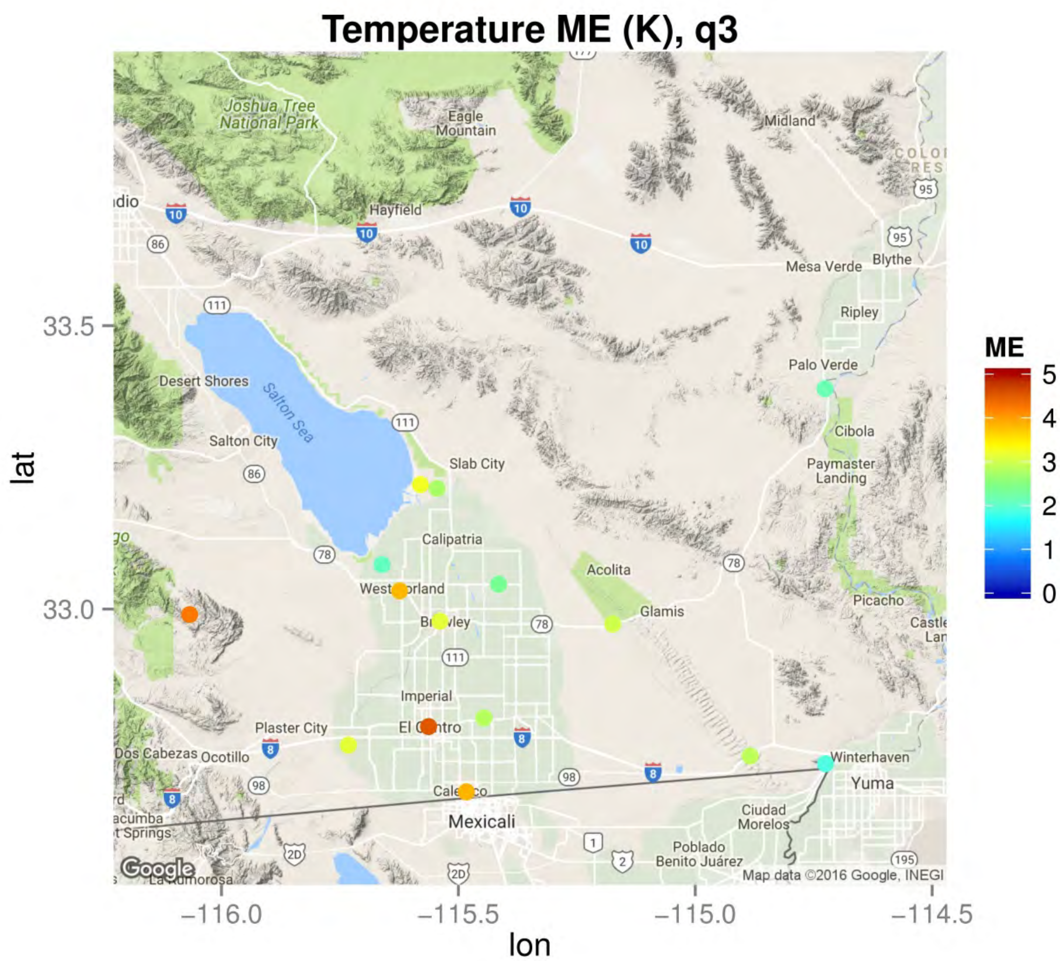

Figure S. 27 Temperature mean error in the third quarter of 2012

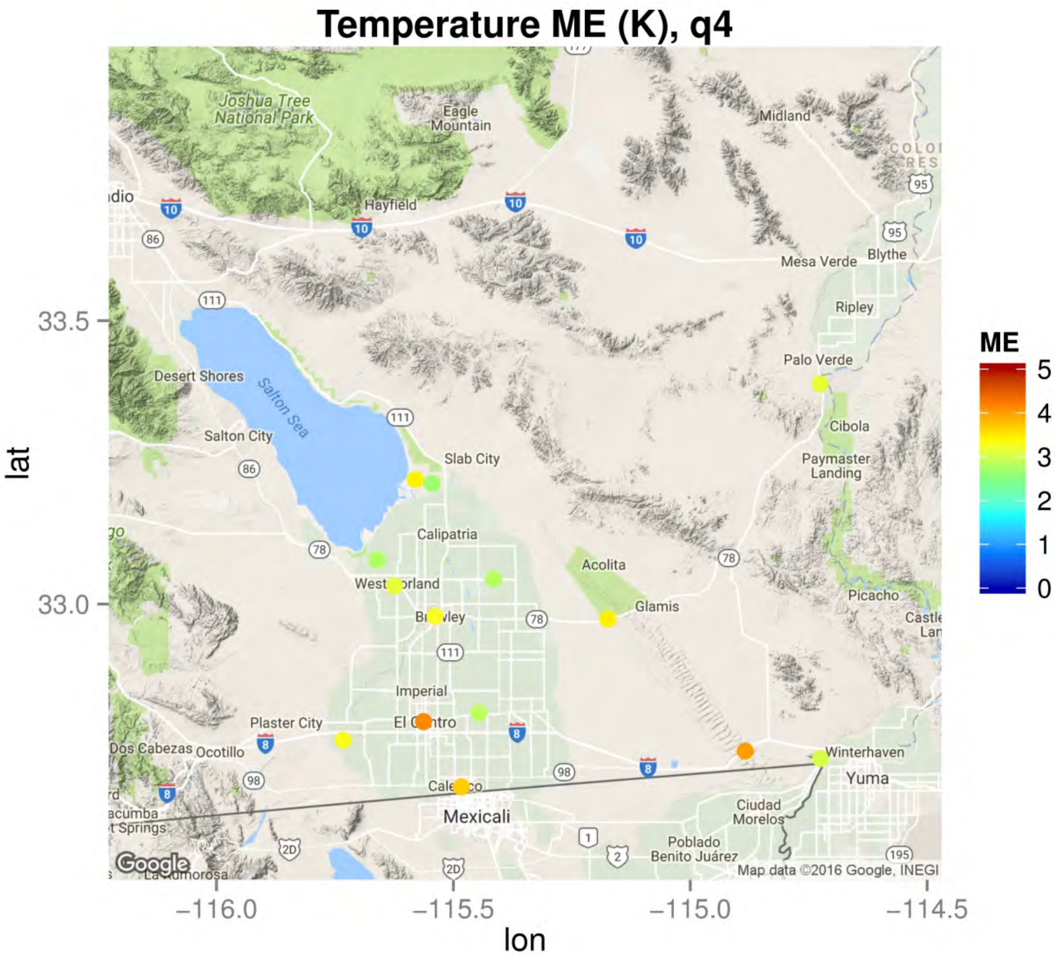

Figure S. 28 Temperature mean error in the fourth quarter of 2012

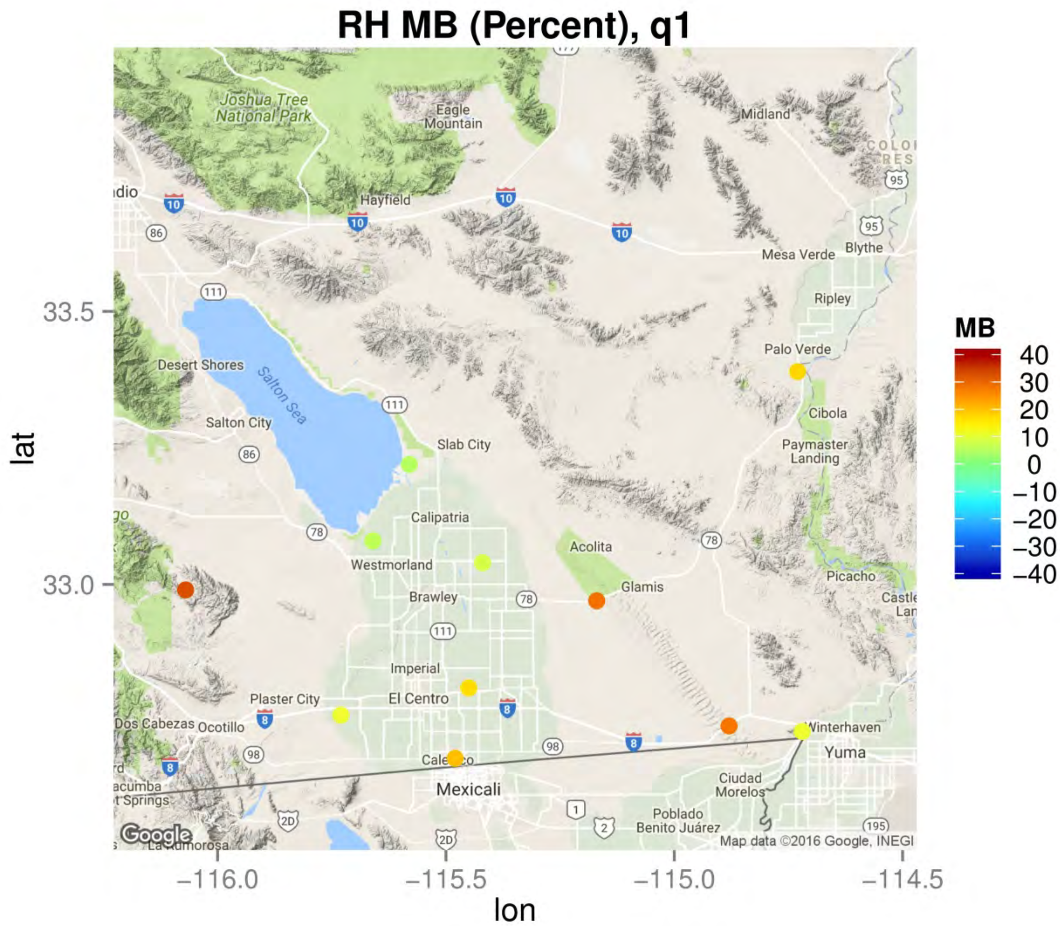

Figure S. 29 Relative humidity mean bias in the first quarter of 2012

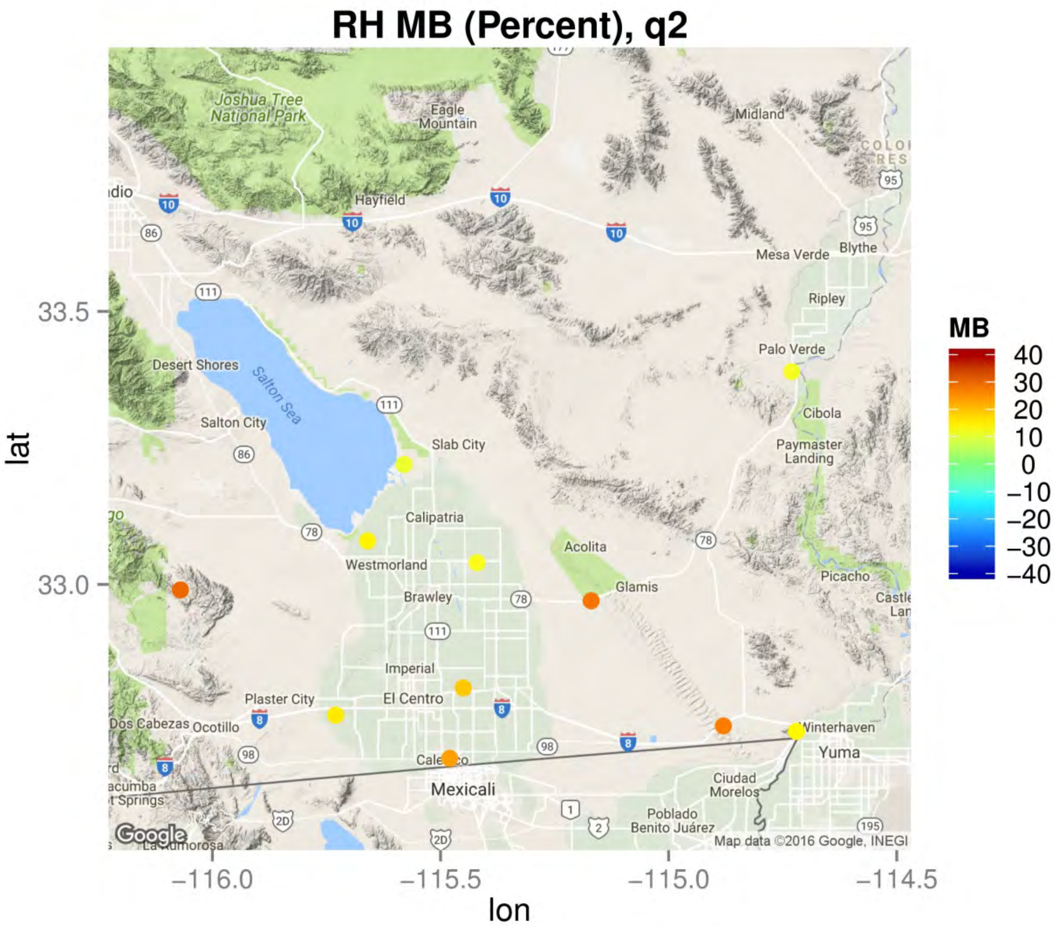

Figure S. 30 Relative humidity mean bias in the second quarter of 2012

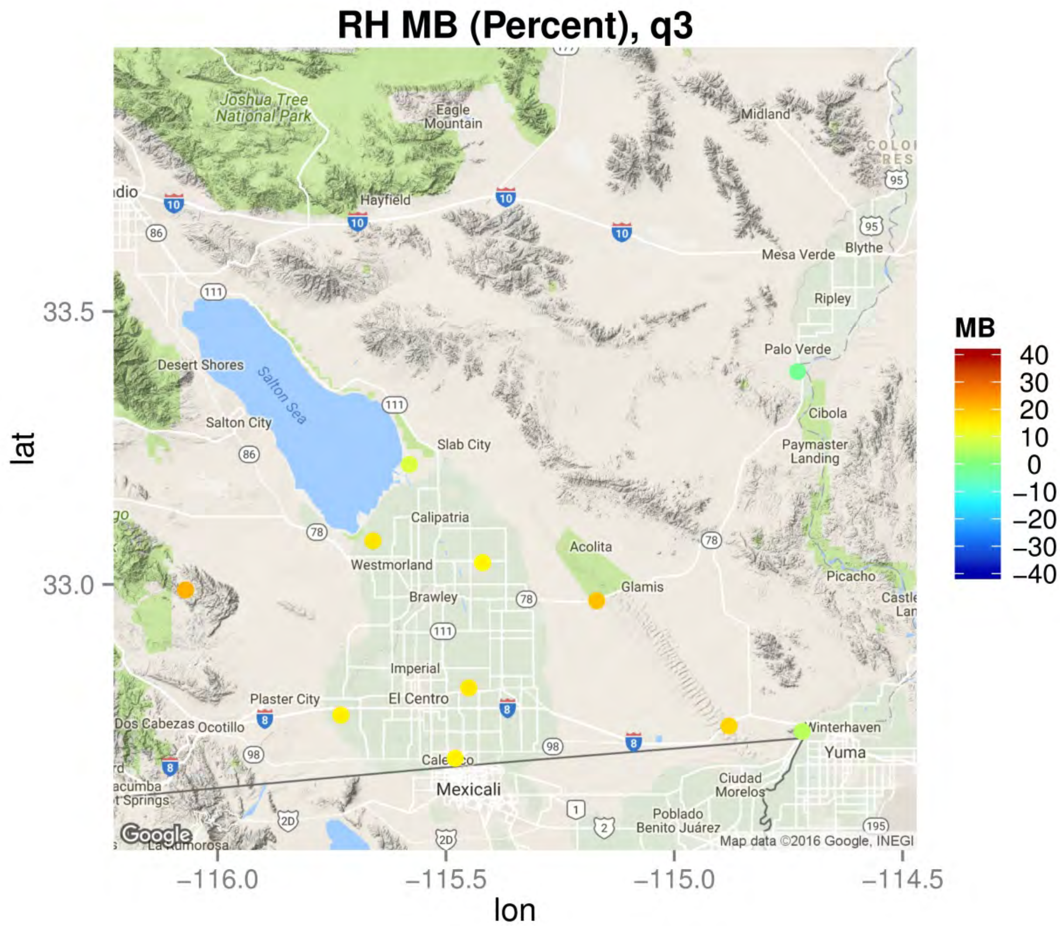

Figure S. 31 Relative humidity mean bias in the third quarter of 2012

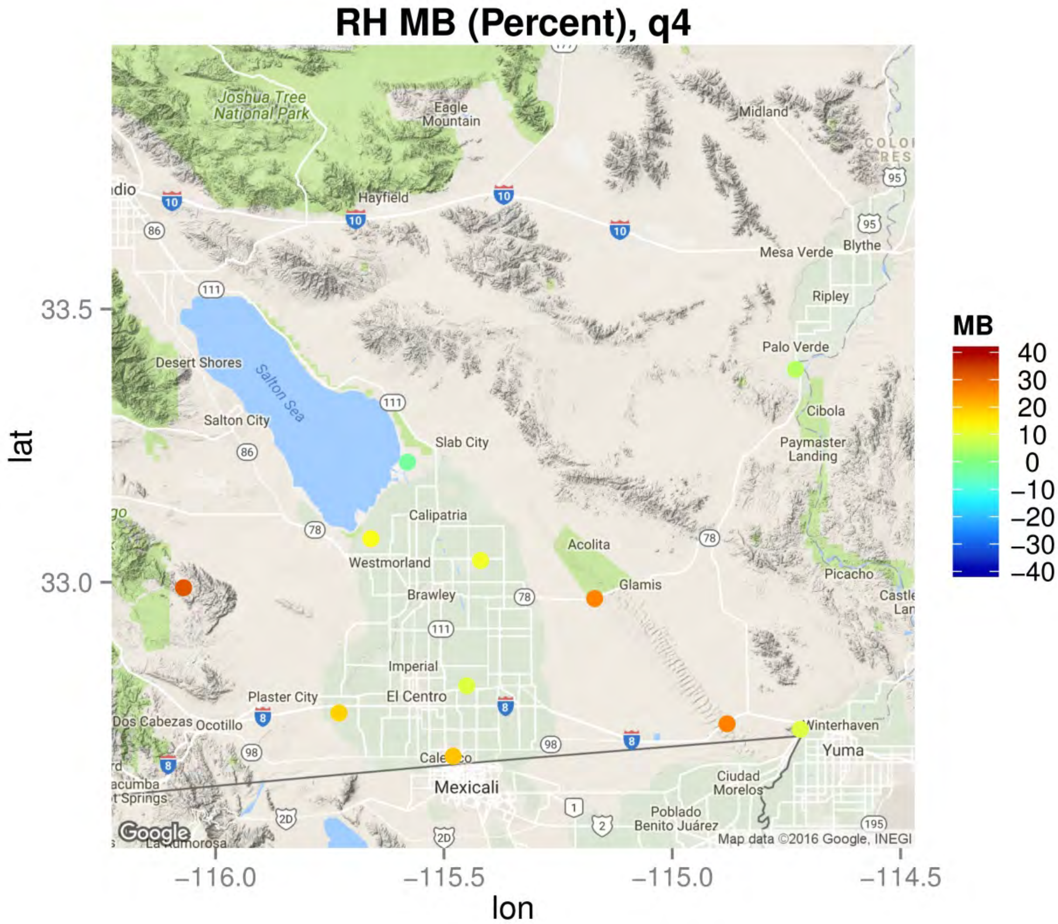

Figure S. 32 Relative humidity mean bias in the fourth quarter of 2012

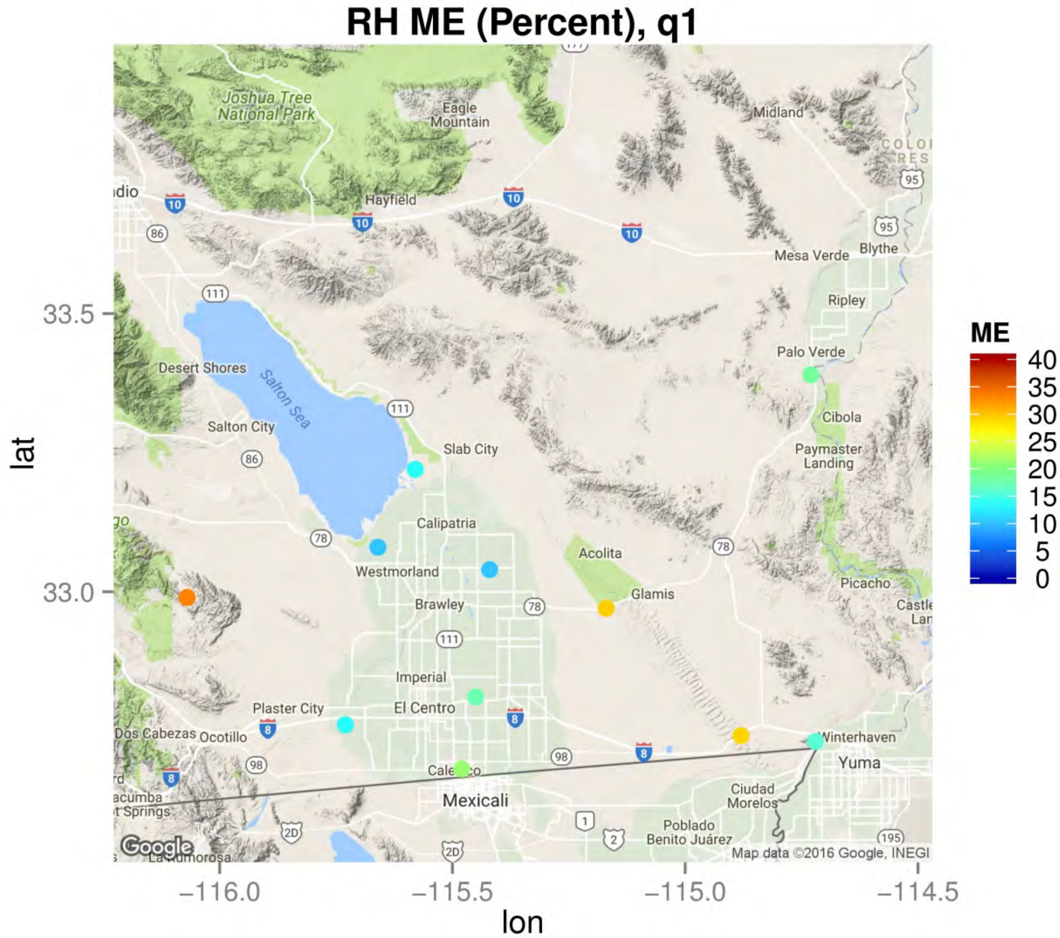

Figure S. 33 Relative humidity mean error in the first quarter of 2012

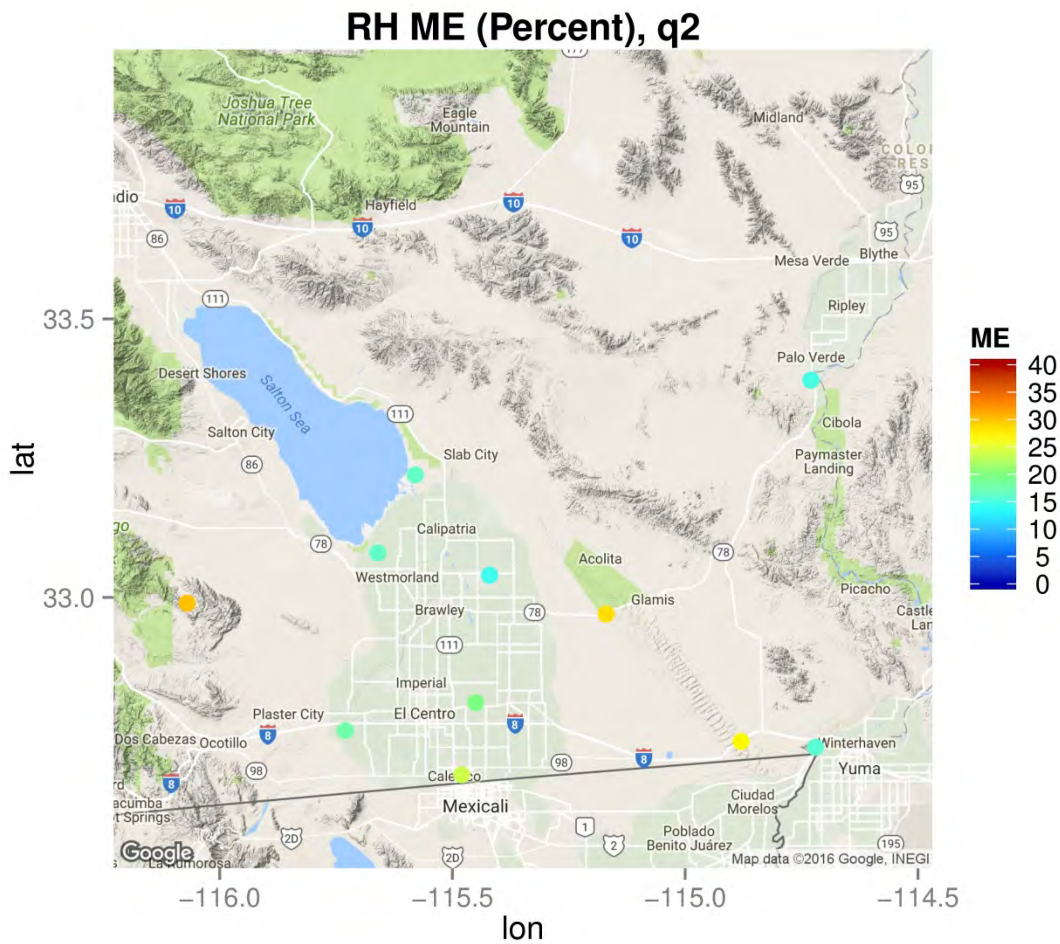

Figure S. 34 Relative humidity mean error in the second quarter of 2012

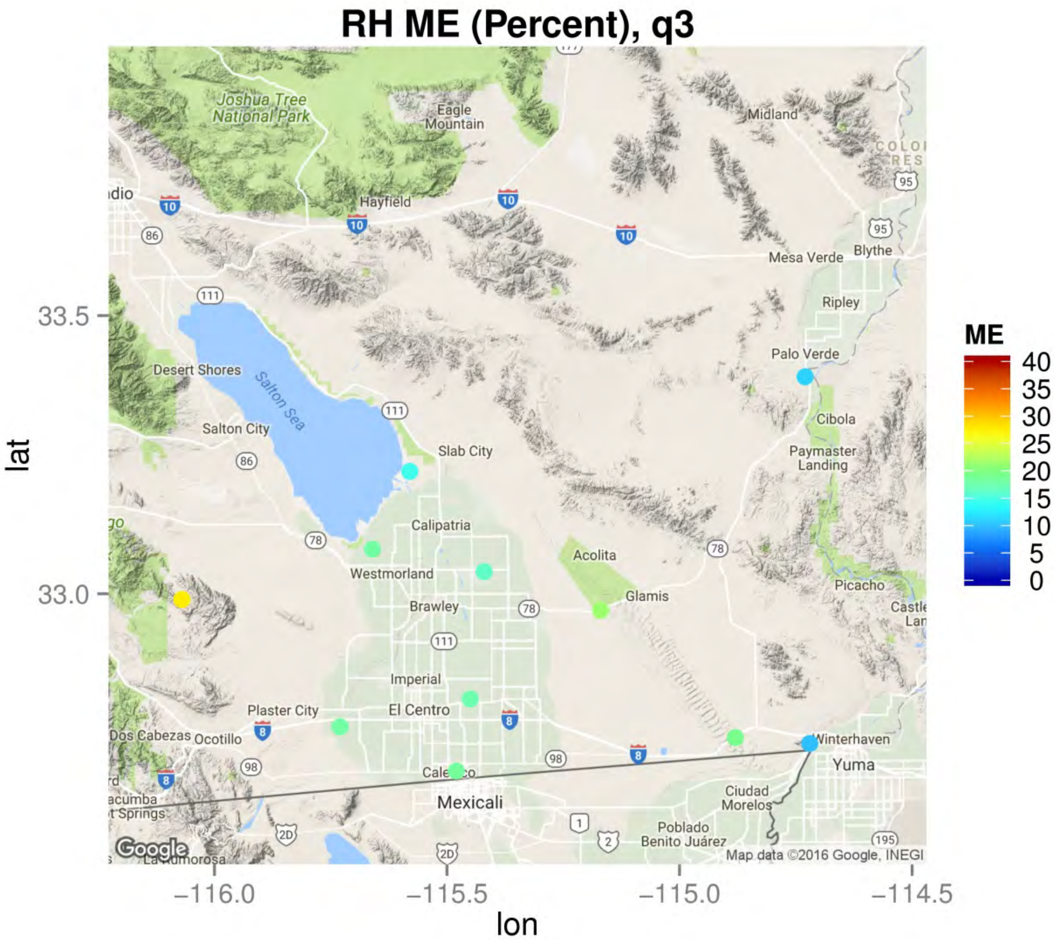

Figure S. 35 Relative humidity mean error in the third quarter of 2012

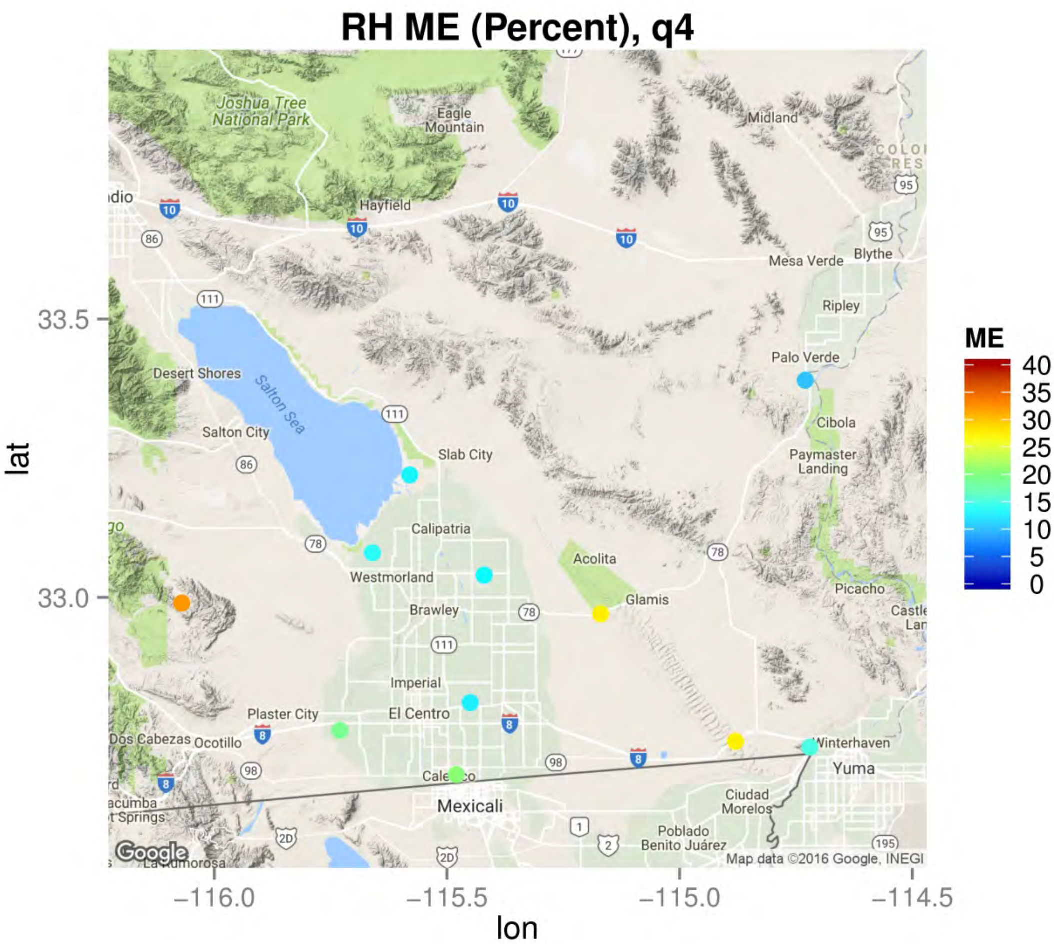

Figure S. 36 Relative humidity mean error in the fourth quarter of 2012

APPENDIX E:
PHOTOCHEMICAL MODELING PROTOCOL

Photochemical Modeling for the 8-Hour Ozone and Annual/24-hour $PM_{2.5}$ State Implementation Plans

Prepared by
California Air Resources Board

Prepared for
United States Environmental Protection Agency Region IX

November 13, 2017

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ACRONYMS

ARCTAS-CARB – California portion of the Arctic Research of the Composition of the Troposphere from Aircraft and Satellites conducted in 2008

BCs – Boundary Conditions

CalNex – Research at the Nexus of Air Quality and Climate Change conducted in 2010

CARB – California Air Resources Board

CCOS - Central California Ozone Study

CMAQ Model – Community Multi-scale Air Quality Model

CIT – California Institute of Technology

CRPAQS – California Regional PM_{10}/$PM_{2.5}$ Air Quality Study

DISCOVER-AQ - Deriving Information on Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality

DV – Design Value

FDDA – Four-Dimensional Data Assimilation

FEM – Federal Equivalence Monitors

FRM – Federal Reference Monitors

HNO_3 – Nitric Acid

ICs – Initial Conditions

IMPROVE – Interagency Monitoring of Protected Visual Environments

IMS-95 – Integrated Monitoring Study of 1995

LIDAR – Light Detection And Ranging

MDA – Maximum Daily Average

MM5 – Mesoscale Meteorological Model Version 5

MOZART – Model for Ozone and Related chemical Tracers

NARR - North American Regional Reanalysis

NCAR – National Center for Atmospheric Research

NCEP – National Centers for Environmental Prediction

NH_3 – Ammonia

NOAA - National Oceanic and Atmospheric Administration

NO_x – Oxides of nitrogen

OC – Organic Carbon

OFP - Ozone Forming Potential

PAMS – Photochemical Assessment Monitoring Stations

PAN – Peroxy Acetyl Nitrate

$PM_{2.5}$ – Particulate Matter with aerodynamic diameter less than 2.5 micrometers

PM_{10} – Particulate Matter with aerodynamic diameter less than 10 micrometers

RH – Relative Humidity

ROG – Reactive Organic Gases

RRF – Relative Response Factor

RSAC – Reactivity Scientific Advisory Committee

SANDWICH – Application of the Sulfate, Adjusted Nitrate, Derived Water, Inferred Carbonaceous Material Balance Approach

SAPRC – Statewide Air Pollution Research Center

SARMAP – SJVAQS/AUSPEX Regional Modeling Adaptation Project

SCAQMD – South Coast Air Quality Management District

SIP – State Implementation Plan

SJV – San Joaquin Valley

SJVAB – San Joaquin Valley Air Basin (SJVAB)

SJVUAPCD – San Joaquin Valley Unified Air Pollution Control District

SJVAQS/AUSPEX – San Joaquin Valley Air Quality Study/Atmospheric Utilities Signatures Predictions and Experiments

SLAMS – State and Local Air Monitoring Stations

SMAQMD – Sacramento Metropolitan Air Quality Management District

SMAT – Application of the Speciated Modeled Attainment Test

SOA – Secondary Organic Aerosol

SO_x – Oxides of Sulfur

STN – Speciated Trend Network

UCD – University of California at Davis

U.S. EPA – United States Environmental Protection Agency

VOC – Volatile Organic Compounds

WRF Model – Weather and Research Forecast Mode

1. INTRODUCTION

The purpose of this modeling protocol is to detail and formalize the procedures for conducting the photochemical modeling that forms the basis of the attainment demonstration for the 8-hour ozone and annual/24-hour $PM_{2.5}$ State Implementation Plans (SIPs) for California. The protocol is intended to communicate up front how the model attainment test will be performed. In addition, this protocol discusses analyses that are intended to help corroborate the findings of the model attainment test.

CARB and local Air Districts jointly develop the emission inventories, which are an integral part of the modeling. Working closely with the Districts, the CARB performs the meteorological and air quality modeling used in the development and adoption of a local air quality plan by each District. Upon approval by the CARB, the SIP will be submitted to U.S.EPA for approval.

1.1 Modeling roles for the current SIP

The Clean Air Act (Act) establishes the planning requirements for all those areas that routinely exceed the health-based air quality standards. These nonattainment areas must adopt and implement a SIP that demonstrates how they will attain the standards by specified dates. Air quality modeling is an important technical component of the SIP, as it is used in combination with other technical information to project the attainment status of an area and to develop appropriate emission control strategies to achieve attainment.

CARB and local Air Districts will jointly develop the emission inventories, which are an integral part of the modeling. Working closely with the Districts, the CARB will perform the meteorological and air quality modeling. Districts will then develop and adopt their local air quality plan. Upon approval by the CARB, the SIP will be submitted to U.S.EPA for approval.

1.2 Stakeholder participation

Public participation constitutes an integral part of the SIP development. It is equally important in all technical aspects of SIP development, including the modeling. As the SIP is developed, the Air Districts and CARB will hold public workshops on the modeling and other SIP elements. Representatives from the private sector, environmental interest groups, academia, and the federal, state, and local public sectors are invited to attend and provide comments. In addition, Draft Plan documents will be available for public review and comment at various stages of plan development and at least 30 days before Plan consideration by the Districts' Governing Boards and subsequently by the CARB

Board. These documents will include descriptions of the technical aspects of the SIP. Stakeholders have the choice to provide written and in-person comments at any of the Plan workshops and public Board hearings. The agencies take the comments into consideration when finalizing the Plan.

1.3 Involvement of external scientific/technical experts and their input on the photochemical modeling

During the development of the modeling protocol for the 2012 SJV 24-hour $PM_{2.5}$ SIP (SJVUAPCD, 2012), CARB and the San Joaquin Valley Air Pollution Control District (SJVAPCD) engaged a group of experts on prognostic meteorological modeling and photochemical/aerosol modeling to help prepare the modeling protocol document.

The structure of the technical expert group was as follows:

Conveners: John DaMassa – CARB
Samir Sheikh – SJVAPCD
Members: Scott Bohning – U.S. EPA Region 9
Ajith Kaduwela – CARB
James Kelly – U.S. EPA Office of Air Quality Planning and Standards
Michael Kleeman – University of California at Davis
Jonathan Pleim – U.S. EPA Office of Research and Development
Anthony Wexler – University of California at Davis

The technical consultant group provided technical consultations/guidance to the staff at CARB and SJVAPCD during the development of the protocol. Specifically, the group provided technical expertise on the following components of the protocol:

- Selection of the physics and chemistry options for the prognostic meteorological and photochemical air quality models
- Selection of methods to prepare initial and boundary conditions for the air quality model
- Performance evaluations of both prognostic meteorological and photochemical air quality models. This includes statistical, diagnostic, and phenomenological evaluations of simulated results.
- Selection of emissions profiles (size and speciation) for particulate-matter emissions.
- Methods to determine the limiting precursors for $PM_{2.5}$ formation.

- Application of the Sulfate, Adjusted Nitrate, Derived Water, Inferred Carbonaceous Material Balance Approach (SANDWICH) with potential modifications.
- Application of the Speciated Modeled Attainment Test (SMAT).
- Selection of methodologies for the determination of $PM_{2.5}$ precursor equivalency ratios.
- Preparation of Technical Support Documents.

The current approach to regional air quality modeling has not changed significantly since the 2012 SJV 24-hour $PM_{2.5}$ SIP (SJVUAPCD, 2012), so the expertise provided on the above components to the protocol remain highly relevant. In addition, since regional air quality modeling simulates ozone chemistry and PM chemistry/formation simultaneously, there is generally no difference in how the models are configured and simulations conducted for ozone vs. PM. Therefore, development of this modeling protocol will rely heavily on the recommendations made by this group of technical experts, as well as recently published work in peer-review journals related to regional air quality modeling.

1.4 Schedule for completion of the Plan

Final area designations kick-off the three year SIP development process. For the first two years, efforts center on updates and improvements to the Plan’s technical and scientific underpinnings. These include the development of emission inventories, selection of modeling periods, model selection, model input preparation, model performance evaluation and supplemental analyses. During the last year, modeling, further supplemental analyses and control strategy development proceed in an iterative manner and the public participation process gets under way. After thorough review the District Board and subsequently the CARB consider the Plan. The Plan is then submitted to U.S. EPA. Table 1-1 in the Appendix corresponding to the appropriate region/standard (e.g., SJV 0.075 ppm 8-hour ozone) summarizes the overall anticipated schedule for Plan completion.

2. DESCRIPTION OF THE CONCEPTUAL MODEL FOR THE NONATTAINMENT AREA

See Section 2 in the Appendix corresponding to the appropriate region/standard (e.g., SJV 0.075 ppm 8-hour ozone).

3. SELECTION OF MODELING PERIODS

3.1 Reference Year Selection and Justification

From an air quality and emissions perspective, CARB and the Districts have selected 2012 as the base year for DV calculation and for the modeled attainment test. For the SJV, the $PM_{2.5}$ model attainment test will utilize 2013 instead of 2012. These baseline values will serve as the anchor point for estimating future year projected DVs.

The selection of 2012/13 is based on the following four considerations:

- Most complete and up to date emissions inventory, which reduces the uncertainty associated with future emissions projections.
- Analysis of meteorological adjusted air quality trends to determine recent years with meteorology most conducive to ozone and $PM_{2.5}$ formation and buildup.
- Availability of research-grade wintertime field measurements in the Valley, which captured two significant pollution episodes during the DISCOVER-AQ field study (January-February 2013).
- The SJV $PM_{2.5}$ DVs for year 2013 were some of the highest in recent years, making 2013 a conservative choice for attainment demonstration modeling.

3.2 Future Year Selection and Justification

The future year modeled is determined by the year for which attainment must be demonstrated. Table 3-1 lists the year in which attainment must be demonstrated for the various ozone and $PM_{2.5}$ standards and non-attainment regions in California.

Table 3-1. Future attainment year by non-attainment region and NAAQS. 0.08 ppm and 0.075 ppm refer to the 1997 and 2008 8-hour ozone standards, respectively. 15 ug/m^3 and 12 ug/m^3 refer to the 1997 and 2012 annual $PM_{2.5}$ standards, respectively. 35 ug/m^3 refers to the 2006 24-hour $PM_{2.5}$ standard, and 1-hr ozone refers to the revoked 1979 0.12 ppm 1-hour ozone standard.

Area	Year								
	2031	2026	2025	2024	2023	2021	2020	2019	2017
Southern California Modeling Domain									
South Coast	0.075 ppm	--	--	--	0.08 ppm	12 µg/m^3	--	--	--
Mojave/Coachella	--	0.075 ppm	--	--	--	--	--	--	0.08 ppm
Imperial County	--	--	--	--	--	12 µg/m^3	--	--	0.075 ppm
Ventura County	--	--	--	--	--	--	0.075 ppm	--	--
San Diego	--	--	--	--	--	--	--	--	0.075 ppm
Northern California Modeling Domain									
San Joaquin Valley	0.075 ppm	--	[1]12 µg/m^3	35 µg/m^3	--	[2]12 µg/m^3	15 µg/m^3	35 µg/m^3	1-hr ozone
Sacramento Metropolitan	--	0.075 ppm	--	--	--	--	--	--	--
Portola-Plumas County	--	--	--	--	--	12 µg/m^3	--	--	--
East Kern	--	--	--	--	--	--	--	--	0.075 ppm
W. Nevada County	--	--	--	--	--	--	--	--	0.075 ppm

[1] Serious classification attainment date

[2] Moderate classification attainment date

3.3 Justification for Seasonal/Annual Modeling Rather than Episodic Modeling

In the past, computational constraints restricted the time period modeled for a SIP attainment demonstration to a few episodes (e.g., 2007 SJV 8-hr ozone SIP (SJVUAPCD, 2007), 2007 SC 8-hr ozone SIP (SCAQMD, 2012) and 2009 Sacramento

8-hr ozone SIP (SMAQMD, 2012)). However, as computers have become faster and large amounts of data storage have become readily accessible, there is no longer a need to restrict modeling periods to only a few episodes. In more recent years, SIP modeling in California has covered the entire ozone or peak $PM_{2.5}$ seasons (2012 SC 8-hour ozone and 24-hour $PM_{2.5}$ SIP (SCAQMD, 2012), 2012 SJV 24-hour $PM_{2.5}$ SIP (SJVUAPCD, 2012) and 2013 SJV 1-hr ozone SIP (SJVUAPCD,2013)), or an entire year in the case of annual $PM_{2.5}$ (2008 SJV annual $PM_{2.5}$ SIP (SJVUAPCD, 2008)) The same is true for other regulatory modeling platforms outside of California (Boylan and Russell, 2006; Morris et al., 2006; Rodriguez et al., 2009; Simon et al., 2012; Tesche et al., 2006; U.S. EPA, 2011a, b).

Recent ozone based studies, which focused on model performance evaluation for regulatory assessment, have recommended the use of modeling results covering the full synoptic cycles and full ozone seasons (Hogrefe et al., 2000; Vizuete et al., 2011). This enables a more complete assessment of ozone response to emission controls under a wide range of meteorological conditions. The same is true for modeling conducted for peak 24-hour $PM_{2.5}$. Consistent with the shift to seasonal or annual modeling in most regulatory modeling applications, modeling for the 8-hour ozone standard will cover the entire ozone season (May – September), modeling for the annual 24-hour $PM_{2.5}$ standard will be conducted for the entire year, and modeling for the 24-hour $PM_{2.5}$ standard will, at a minimum, cover the months in which peak 24-hour $PM_{2.5}$ occurs (e.g., October – March in the SJV) and will be conducted annually whenever possible.

4. DEVELOPMENT OF EMISSION INVENTORIES

For a detailed description of the emissions inventory, updates to the inventory, and how it was processed from the planning totals to a gridded inventory for modeling, see the Emissions Inventory Appendix.

5. MODELS AND INPUTS

5.1 Meteorological Model

Meteorological model selection is based on a need to accurately simulate the synoptic and mesoscale meteorological features observed during the selected modeling period. The main difficulties in accomplishing this are California’s extremely complex terrain and its diverse climate. It is desirable that atmospheric modeling adequately represent essential meteorological fields such as wind flows, ambient temperature variation, evolution of the boundary layer, and atmospheric moisture content to properly characterize the meteorological component of photochemical modeling.

In the past, the CARB has applied prognostic, diagnostic, and hybrid models to prepare meteorological fields for photochemical modeling. There are various numerical models that are used by the scientific community to study the meteorological characteristics of an air pollution episode. For this SIP modeling platform, the Weather and Research Forecasting (WRF) model (Skaramock et al, 2005) will be used to develop the meteorological fields that drive the photochemical modeling. The U.S. EPA (2014) recommends the use of a well-supported grid-based mesoscale meteorological model for generating meteorological inputs. The WRF model is a community-based mesoscale prediction model, which represents the state-of-the-science and has a large community of model users and developers who frequently update the model as new science becomes available. In recent years, WRF has been applied in California to generate meteorological fields for numerous air quality studies (e.g., Angevine, et al., 2012; Baker et al., 2015; Ensberg et al., 2013; Fast et al., 2014; Hu et al., 2014a, 2014b; Huang et al., 2010; Kelly et al., 2014; Lu et al., 2012; Mahmud et al., 2010), and has been shown to reasonably reproduce the observed meteorology in California.

5.1.1 Meteorological Modeling Domain

The WRF meteorological modeling domain consists of three nested grids of 36 km, 12 km and 4 km uniform horizontal grid spacing (illustrated in Figure 5-1). The purpose of the coarse, 36 km grid (D01) is to provide synoptic-scale conditions to all three grids, while the 12 km grid (D02) is used to provide finer resolution data that feeds into the 4 km grid (D03). The D01 grid is centered at 37 ˚N and 120.5 ˚W and was chosen so that the inner two grids, D02 and D03, would nest inside of D03 and be sufficiently far away from the boundaries to minimize boundary influences. The D01 grid consists of 90 x 90 grid cells, while the D02 and D03 grids encompass 192 x 192 and 327 x 297 grid cells, respectively, with an origin at -696 km x -576 km (Lambert Conformal projection). WRF will be run for the three nested domains simultaneously with two-way feedback between the parent and the nest grids. The D01 and D02 grids are meant to resolve the larger scale synoptic weather systems, while the D03 grid is intended to resolve the finer details of the atmospheric conditions and will be used to drive the air quality model simulations. All three domains will utilize 30 vertical sigma layers (defined in Table 5-1), as well as the various physics options listed in Table 5-2 for each domain.
The initial and boundary conditions (IC/BCs) for WRF will be prepared based on 3-D North American Regional Reanalysis (NARR) data that are archived at the National Center for Atmospheric Research (NCAR). These data have a 32 km horizontal resolution. Boundary conditions to WRF are updated at 6-hour intervals for the 36 km

grid (D01). In addition, surface and upper air observations obtained from NCAR will be used to further refine the analysis data that are used to generate the IC/BCs. Analysis nudging will be employed in the outer 36km grid (D01) to ensure that the simulated meteorological fields are constrained and do not deviate from the observed meteorology.

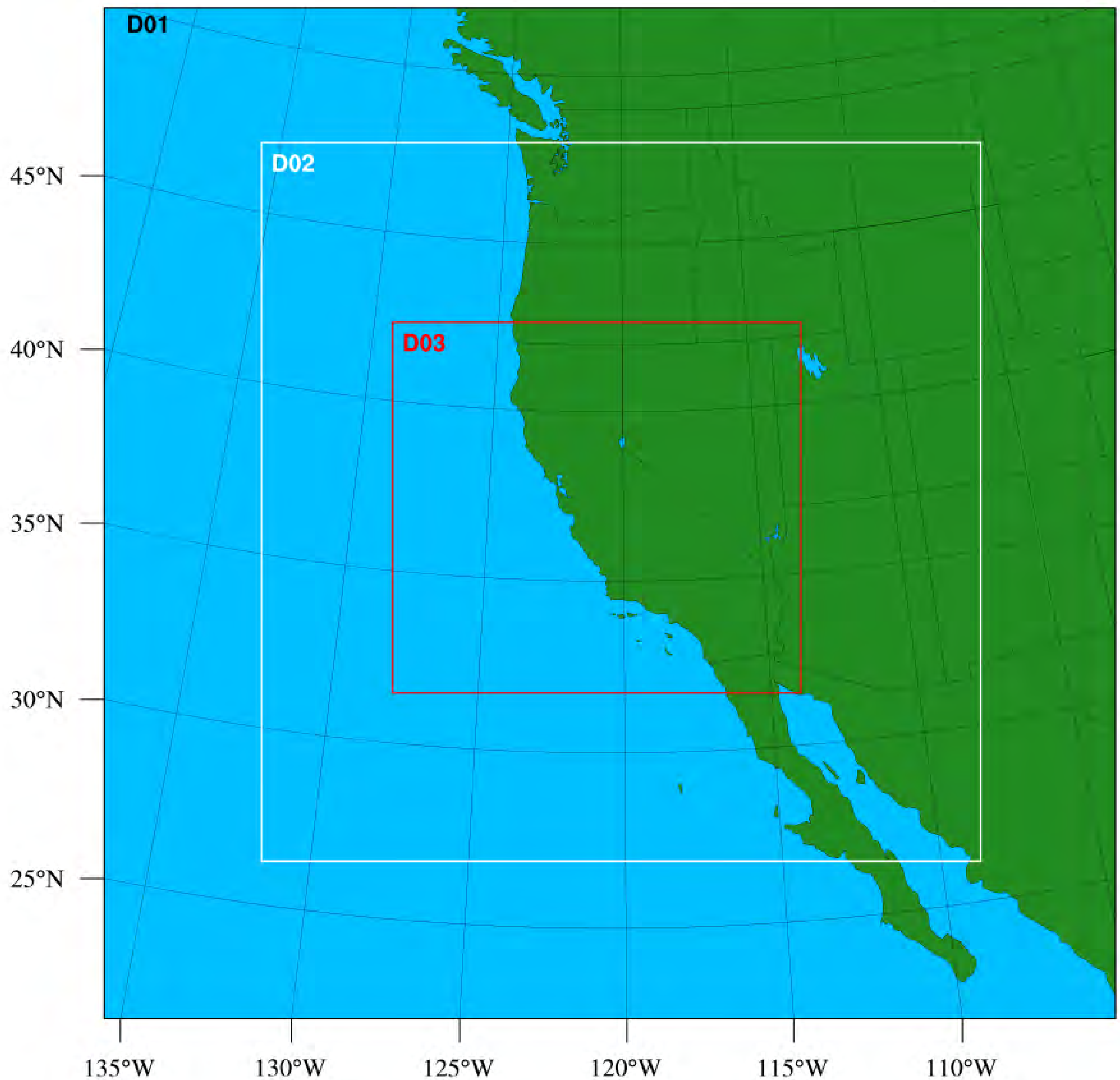

Figure 5-1. The three nested grids for the WRF model (D01 36km; D02 12km; and D03 4km).

Table 5-1. WRF vertical layer structure.

Layer Number	Height (m)	Layer Thickness (m)
30	16082	1192
29	14890	1134
28	13756	1081
27	12675	1032
26	11643	996
25	10647	970
24	9677	959
23	8719	961
22	7757	978
21	6779	993
20	5786	967
19	4819	815
18	4004	685
17	3319	575
16	2744	482
15	2262	403
14	1859	334
13	1525	279
12	1246	233
11	1013	194
10	819	162
9	657	135
8	522	113
7	409	94
6	315	79
5	236	66
4	170	55
3	115	46
2	69	38
1	31	31
0	0	0

Note: Shaded layers denote the subset of vertical layers to be used in the CMAQ photochemical model simulations. Further details on the CMAQ model configuration and settings can be found in subsequent sections.

Table 5-2. WRF Physics Options.

Physics Option	Domain		
	D01 (36 km)	D02 (12 km)	D03 (4 km)
Microphysics	WSM 6-class graupel scheme	WSM 6-class graupel scheme	WSM 6-class graupel scheme
Longwave radiation	RRTM	RRTM	RRTM
Shortwave radiation	Dudhia scheme	Dudhia scheme	Dudhia scheme
Surface layer	Revised MM5 Monin-Obukhov	Revised MM5 Monin-Obukhov	Revised MM5 Monin-Obukhov
Land surface	Pleim-Xiu LSM	Pleim-Xiu LSM	Pleim-Xiu LSM
Planetary Boundary Layer	YSU	YSU	YSU
Cumulus Parameterization	Kain-Fritsch scheme	Kain-Fritsch scheme	None

5.2 Photochemical Model

The U.S. EPA modeling guidance (U.S. EPA, 2014) requires several factors to be considered as criteria for choosing a qualifying air quality model to support the attainment demonstration. These criteria include: (1) It should have received a scientific peer review; (2) It should be appropriate for the specific application on a theoretical basis; (3) It should be used with databases which are available and adequate to support its application; (4) It should be shown to have performed well in past modeling applications; and (5). It should be applied consistently with an established protocol on methods and procedures (U.S. EPA, 2014). In addition, it should be well documented with a user's guide as well as technical descriptions. For the ozone modeled attainment test, a grid-based photochemical model is necessary to offer the best available representation of important atmospheric processes and the ability to analyze the impacts of proposed emission controls on ozone mixing ratios. In CARB's SIP modeling platform, the Community Multiscale Air Quality (CMAQ) Modeling System has been selected as the air quality model for use in attainment demonstrations of NAAQS for ozone and $PM_{2.5}$.

The CMAQ model, a state-of-the-science "one-atmosphere" modeling system developed by U.S. EPA, was designed for applications ranging from regulatory and policy analysis to investigating the atmospheric chemistry and physics that contribute to air pollution. CMAQ is a three-dimensional Eulerian modeling system that simulates ozone, particulate matter, toxic air pollutants, visibility, and acidic pollutant species throughout the troposphere (UNC, 2010). The model has undergone peer review every few years and represents the state-of-the-science (Brown et al., 2011). The CMAQ model is regularly updated to incorporate new chemical and aerosol mechanisms, algorithms, and data as they become available in the scientific literature (e.g., Appel et al., 2013; Foley, et al., 2010; Pye and Pouliot, 2012;). In addition, the CMAQ model is well documented in terms of its underlying scientific algorithms as well as guidance on operational uses (e.g., Appel et al., 2013; Binkowski and Roselle, 2003; Byun and Ching, 1999; Byun and Schere, 2006; Carlton et al., 2010; Foley et al., 2010; Kelly, et al., 2010a; Pye and Pouliot, 2012; UNC, 2010).

The CMAQ model was the regional air quality model used for the 2008 SJV annual $PM_{2.5}$ SIP (SJVUAPCD, 2008), the 2012 SJV 24-hour $PM_{2.5}$ SIP (SJVUAPCD, 2012) and the 2013 SJV 1-hr ozone SIP (SJVUAPCD, 2013). A number of previous studies have also used the CMAQ model to study ozone and $PM_{2.5}$ formation in the SJV (e.g., Jin et al., 2008, 2010b; Kelly et al., 2010b; Liang and Kaduwela, 2005; Livingstone, et al., 2009; Pun et al, 2009; Tonse et al., 2008; Vijayaraghavan et al., 2006; Zhang et al., 2010). The CMAQ model has also been used for regulatory analysis for many of U.S. EPA's rules, such as the Clean Air Interstate Rule (U.S. EPA, 2005) and Light-duty and Heavy-duty Greenhouse Gas Emissions Standards (U.S. EPA, 2010, 2011a). There have been numerous applications of the CMAQ model within the U.S. and abroad (e.g., Appel, et al., 2007, 2008; Civerolo et al., 2010; Eder and Yu, 2006; Hogrefe et al., 2004; Lin et al., 2008, 2009; Marmur et al., 2006; O'Neill, et al., 2006; Philips and Finkelstein, 2006; Smyth et al., 2006; Sokhi et al., 2006; Tong et al., 2006; Wilczak et al., 2009; Zhang et al., 2004, 2006), which have shown it to be suitable as a regulatory and scientific tool for investigating air quality. Staff at the CARB has developed expertise in applying the CMAQ model, since it has been used at CARB for over a decade. In addition, technical support for the CMAQ model is readily available from the Community Modeling and Analysis System (CMAS) Center (http://www.cmascenter.org/) established by the U.S. EPA.

The version 5.0.2 of the CMAQ model released in May 2014, (http://www.airqualitymodeling.org/cmaqwiki/index.php?title=CMAQ_version_5.0.2_%28April_2014_release%29_Technical_Documentation), will be used in this SIP modeling platform. Compared to the previous version, CMAQv4.7.1, which was used for the 2012 SJV 24-hour $PM_{2.5}$ SIP (SJVUAPCD, 2012) and the 2013 SJV 1-hour ozone SIP (SJVUAPCD, 2013), CMAQ version 5 and above incorporated substantial new features and enhancements to topics such as gas-phase chemistry, aerosol algorithms, and structure of the numerical code (http://www.airqualitymodeling.org/cmaqwiki/index.php?title=CMAQ_version_5.0_%28February_2012_release%29_Technical_Documentation#RELEASE_NOTES_for_CMAQv5.0_-.C2.A0February_2012).

5.2.1 Photochemical Modeling Domain

Figure 5-2 shows the photochemical modeling domains used by CARB in this modeling platform. The larger domain (dashed black colored box), covering all of California, has a horizontal grid resolution of 12 km and extends from the Pacific Ocean in the west to Eastern Nevada in the east and runs from south of the U.S.-Mexico border in the south to north of the California-Oregon border in the north. The smaller 4 km Northern (green box) and Southern (red box) modeling domains are nested within the outer 12 km domain and utilized to better reflect the finer scale details of meteorology, topography, and emissions. Consistent with the WRF modeling, the 12 km and 4 km CMAQ domains are based on a Lambert Conformal Conic projection with reference longitude at -120.5°W, reference latitude at 37°N, and two standard parallels at 30°N and 60°N. The 30 vertical layers from WRF were mapped onto 18 vertical layers for CMAQ, extending from the surface to 100 mb such that the majority of the vertical layers fall within the planetary boundary layer. This vertical layer structure is based on the WRF sigma-pressure coordinates and the exact layer structure used can be found in Table 5-1. A third 4 km resolution modeling domain (blue box) is nested within the Northern California domain and covers the SJV air basin. This smaller SJV domain may be utilized for $PM_{2.5}$ modeling in the SJV if computational constraints (particularly for annual modeling) require the use of a smaller modeling domain. In prior work, modeling results from the smaller SJV domain were compared to results from the larger Northern California domain and no appreciable differences were noted, provided that both simulations utilized chemical boundary conditions derived from the same statewide 12 km simulation.

For the coarse portions of nested regional grids, the U.S. EPA guidance (U.S. EPA, 2014) suggests a grid cell size of 12 km if feasible but not larger than 36 km. For the fine scale portions of nested regional grids, it is desirable to use a grid cell size of ~4 km (U.S. EPA, 2014). Our selection of modeling domains and grid resolution is consistent with this recommendation. The U.S. EPA guidance (U.S. EPA, 2014) does not require a minimum number of vertical layers for an attainment demonstration, although typical applications of “one- atmosphere” models (with the model top at 50-100 mb) are anywhere from 14 to 35 vertical layers. In the CARB’s current SIP modeling platform, 18 vertical layers will be used in the CMAQ model. The vertical structure is based on the sigma-pressure coordinate, with the layers separated at 1.0, 0.9958, 0.9907, 0.9846, 0.9774, 0.9688, 0.9585, 0.9463, 0.9319, 0.9148, 0.8946, 0.8709, 0.8431, 0.8107, 0.7733, 0.6254, 0.293, 0.0788, and 0.0. As previously noted, this also ensures that the majority of the layers are in the planetary boundary layer.

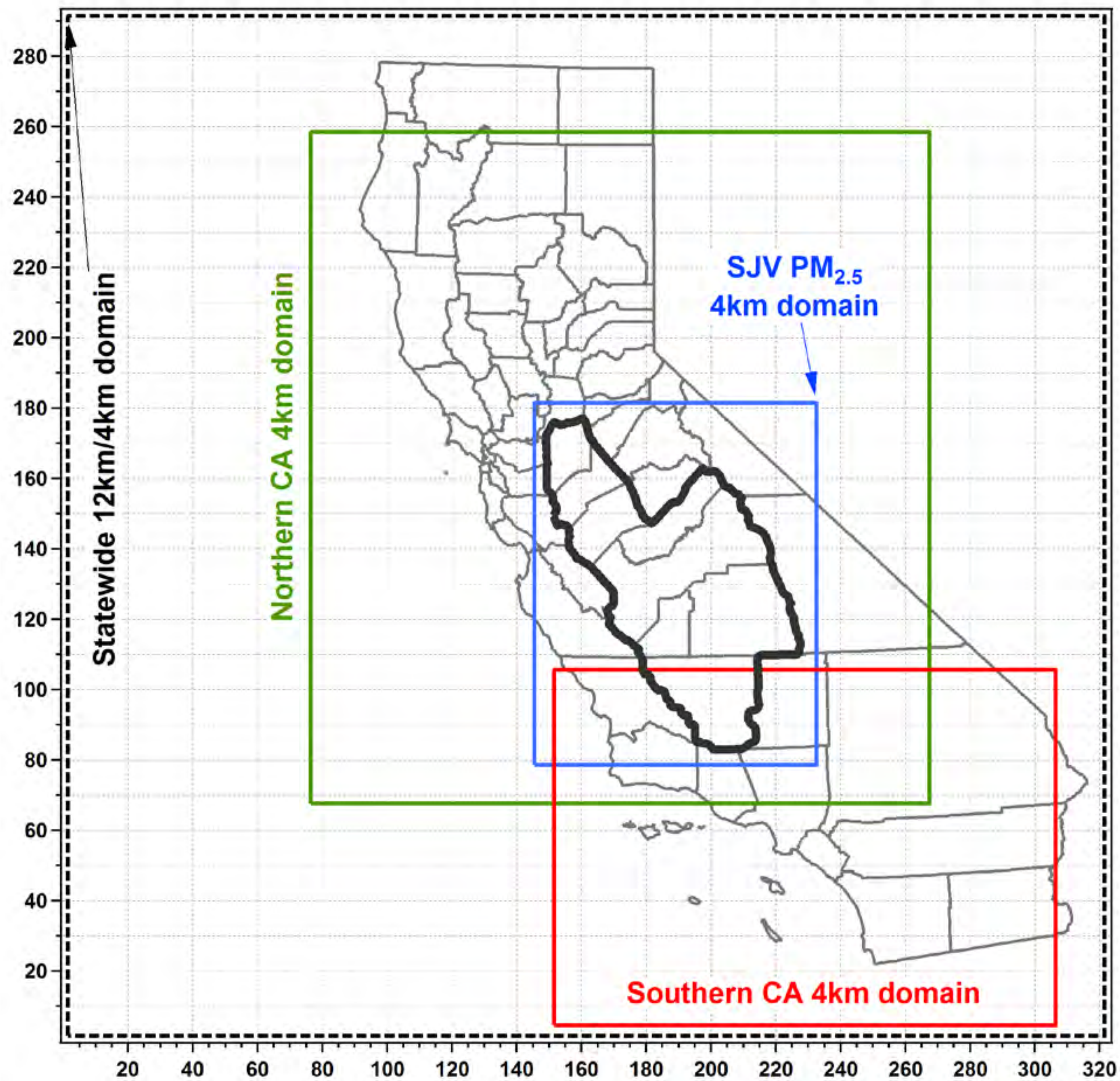

Figure 5-2. CMAQ modeling domains used in this SIP modeling platform. The outer domain (dashed black line) represents the extent of the California statewide domain (shown here with a 4 km horizontal resolution, but utilized in this modeling platform with a 12 km horizontal resolution). Nested higher resolution 4 km modeling domains are highlighted in green and red for Northern/Central California and Southern California, respectively. The smaller SJV $PM_{2.5}$ 4 km domain (colored in blue) is nested within the Northern California 4 km domain.

5.2.2 CMAQ Model Options

Table 5-3 shows the CMAQv5.0.2 configuration utilized in this modeling platform. The same configuration will be used in all simulations for both ozone and $PM_{2.5}$, and for all modeled years. The Intel FORTRAN compiler version 12 will be used to compile all source codes.

Table 5-3. CMAQ v5.0.2 configuration and settings.

Process	Scheme
Horizontal advection	Yamo (Yamartino scheme for mass-conserving advection)
Vertical advection	WRF-based scheme for mass-conserving advection
Horizontal diffusion	Multi-scale
Vertical diffusion	ACM2 (Asymmetric Convective Model version 2)
Gas-phase chemical mechanism	SAPRC07 gas-phase mechanism with version "C" toluene updates
Chemical solver	EBI (Euler Backward Iterative solver)
Aerosol module	Aero6 (the sixth-generation CMAQ aerosol mechanism with extensions for sea salt emissions and thermodynamics; includes a new formulation for secondary organic aerosol yields)
Cloud module	ACM_AE6 (ACM cloud processor that uses the ACM methodology to compute convective mixing with heterogeneous chemistry for AERO6)
Photolysis rate	phot_inline (calculate photolysis rates in-line using simulated aerosols and ozone)

5.2.3 Photochemical Mechanism

The SAPRC07 chemical mechanism will be utilized for all CMAQ simulations. SAPRC07, developed by Dr. William Carter at the University of California, Riverside, is a detailed mechanism describing the gas-phase reactions of volatile organic compounds (VOCs) and oxides of nitrogen (NO_x) (Carter, 2010a, 2010b). It represents a complete update to the SAPRC99 mechanism, which has been used for previous ozone SIP plans in the SJV. The well-known SAPRC family of mechanisms have been used widely in California and the U.S. (e.g., Baker, et al., 2015; Cai et al., 2011; Chen et al., 2014; Dennis et al., 2008; Ensberg, et al., 2013; Hakami, et al., 2004a, 2004b; Hu et al., 2012, 2014a, 2014b; Jackson, et al., 2006; Jin et al., 2008, 2010b; Kelly, et al., 2010b; Lane et al., 2008; Liang and Kaduwela, 2005; Livingstone et al., 2009; Lin et al., 2005; Napelenok, 2006; Pun et al., 2009; Tonse et al., 2008; Ying et al., 2008a, 2008b; Zhang et al., 2010; Zhang and Ying, 2011).

The SAPRC07 mechanism has been fully reviewed by four experts in the field through an CARB funded contract. These reviews can be found at http://www.arb.ca.gov/research/reactivity/rsac.htm. Dr. Derwent's (2010) review compared ozone impacts of 121 organic compounds calculated using SAPRC07 and the Master Chemical Mechanism (MCM) v 3.1 and concluded that the ozone impacts using the two mechanisms were consistent for most compounds. Dr. Azzi (2010) used SAPRC07 to simulate ozone formation from isoprene, toluene, m-xylene, and evaporated fuel in environmental chambers performed in Australia and found that SAPRC07 performed reasonably well for these data. Dr. Harley discussed implementing the SAPRC07 mechanism into 3-D air quality models and brought up the importance of the rate constant of NO_2 + OH. This rate constant in the SAPRC07 mechanism in CMAQv5.0.2 has been updated based on new research (Mollner et al., 2010). Dr. Stockwell (2009) compared individual reactions and rate constants in SAPRC07 to two other mechanisms (CB05 and RADM2) and concluded that SAPRC07 represented a state-of-the-science treatment of atmospheric chemistry.

5.2.4 Aerosol Module

The aerosol mechanism with extensions version 6 with aqueous-phase chemistry (AE6-AQ) will be utilized for all SIP modeling. When coupled with the SAPRC07 chemical mechanism, AE6-AQ simulates the formation and evaporation of aerosol and the evolution of the aerosol size distribution (Foley et al., 2010). AE6-AQ includes a comprehensive, yet computationally efficient, inorganic thermodynamic model ISORROPIA to simulate the physical state and chemical composition of inorganic atmospheric aerosols (Fountoukis and Nenes, 2007). AE6-AQ also features the addition of new $PM_{2.5}$ species, an improved secondary organic aerosol (SOA) formation module, as well as new treatment of atmospheric processing of primary organic aerosol (Appel et al., 2013; Carlton et al., 2010; Simon and Bhave, 2011). These updates to AE6-AQ in CMAQv5.0.2 continue to represent state-of-the-art treatment of aerosol processes in the atmosphere (Brown et al., 2011).

5.2.5 CMAQ Initial and Boundary Conditions (IC/BC) and Spin-Up period

Air quality model initial conditions define the mixing ratio (or concentration) of chemical and aerosol species within the modeling domain at the beginning of the model simulation. Boundary conditions define the chemical species mixing ratio (or concentration) within the air entering or leaving the modeling domain. This section discusses the initial and boundary conditions utilized in the CARB modeling system.

U.S. EPA guidance recommends using a model "spin-up" period by beginning a simulation 3-10 days prior to the period of interest (U.S. EPA, 2014). This "spin-up" period allows the initial conditions to be "washed out" of the system, so that the actual initial conditions have little to no impact on the modeling over the time period of interest, as well as giving sufficient time for the modeled species to come to chemical equilibrium. When conducting annual or seasonal modeling, it is computationally more efficient to simulate each month in parallel rather than the entire year or season sequentially. For each month, the CMAQ simulations will include a seven day spin-up period (i.e., the last seven days of the previous month) for the outer 12 km domain to ensure that the initial conditions are "washed out" of the system. Initial conditions at the beginning of the seven day spin-up period will be based on the default initial conditions that are included with the CMAQ release. The 4 km inner domain simulations will utilize a three day spin-up period, where the initial conditions will be based on output from the corresponding day of the 12 km domain simulation.

In recent years, the use of global chemical transport model (CTM) outputs as boundary conditions (BCs) in regional CTM applications has become increasingly common (Chen et al., 2008; Hogrefe et al., 2011; Lam and Fu, 2009; Lee et al., 2011; Lin et al., 2010), and has been shown to improve model performance in many cases (Appel et al., 2007; Borge et al., 2010; Tang et al., 2007, 2009; Tong and Mauzerall, 2006). The advantage of using global CTM model outputs as opposed to fixed climatological-average BCs is that the global CTM derived BCs capture spatial, diurnal, and seasonal variability, as well as provide a set of chemically consistent pollutant mixing ratios. In the CARB's SIP modeling system, the Model for Ozone And Related chemical Tracers (MOZART; Emmons et al., 2010) will be used to define the boundary conditions for the outer 12 km CMAQ domain, while boundary conditions for the 4 km domain will be derived from the 12 km output. MOZART is a comprehensive global model for simulating atmospheric composition including both gases and bulk aerosols (Emmons et al., 2010). It was developed by the National Center for Atmospheric Research (NCAR), the Max-Planck-Institute for Meteorology (in Germany), and the Geophysical Fluid Dynamics Laboratory (GFDL) of the National Oceanic and Atmospheric Administration (NOAA), and is widely used in the scientific community. In addition to inorganic gases and VOCs, BCs were extracted for aerosol species including elemental carbon, organic matter, sulfate, soil and nitrate. MOZART has been extensively peer-reviewed and applied in a range of studies that utilize its output in defining BCs for regional modeling studies within California and other regions of the U.S. (e.g., Avise et al., 2008; Chen et al., 2008, 2009a, 2009b; Fast et al., 2014; Jathar et al., 2015).

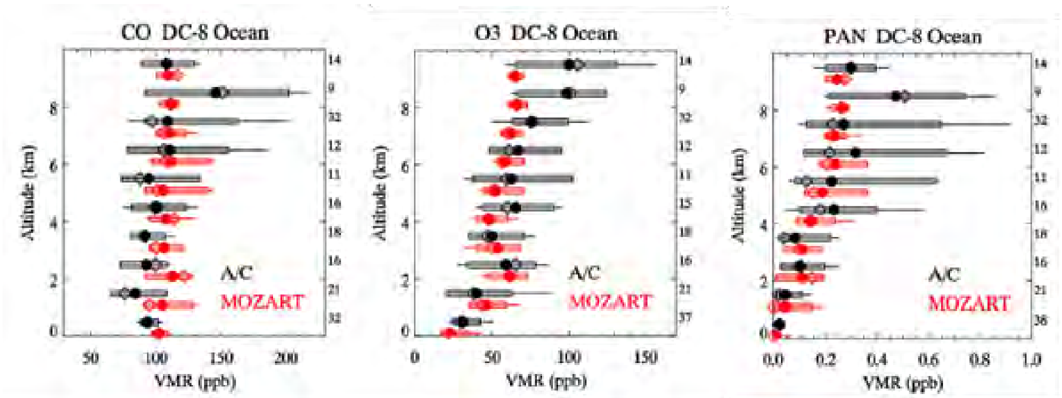

Figure 5-3. Comparison of MOZART (red) simulated CO (left), ozone (center), and PAN (right) to observations (black) along the DC-8 flight track. Shown are mean (filled symbol), median (open symbols), 10th and 90th percentiles (bars) and extremes (lines). The number of data points per 1-km wide altitude bin is shown next to the graphs. Adapted from Figure 2 in Pfister et al. (2011).

In particular, MOZART version 4 (MOZART-4) was recently used in a study characterizing summertime air masses entering California from the Pacific Ocean (Pfister et al., 2011). In their work, Pfister et al. (2011) compared MOZART-4 simulation results to measurements of CO, ozone, and PAN made off the California coast during the ARCTAS-CARB airborne field campaign (Jacob et al., 2010) and showed good agreement between the observations and model results (see Figure 5-3).
The specific MOZART simulations to be utilized in this modeling platform are the MOZART4-GEOS5 simulations by Louisa Emmons (NCAR) for the years 2012 and 2013, which are available for download at http://www.acom.ucar.edu/wrf-chem/mozart.shtml. These simulations are similar to those of Emmons et al. (2010), but with updated meteorological fields. Boundary condition data will be extracted from the MOZART-4 output and processed to CMAQ model ready format using the “mozart2camx” code developed by the Rambol-Environ Corporation (available at http://www.camx.com/download/support-software.aspx). The final BCs represent day-specific mixing ratios, which vary in both space (horizontal and vertical) and time (every six hours).

Per U.S. EPA guidance, the same MOZART derived BCs for the 12 km outer domain will be used for all simulations (e.g., Base Case, Reference, Future, and any sensitivity simulation).

5.3 Quality Assurance of Model Inputs

In developing the IC/BCs and Four Dimensional Data Assimilation (FDDA) datasets for WRF, quality control is performed on all associated meteorological data. Generally, all surface and upper air meteorological data are plotted in space and time to identify extreme values that are suspected to be "outliers". Data points are also compared to other, similar surrounding data points to determine whether there are any large relative discrepancies. If a scientifically plausible reason for the occurrence of suspected outliers is not known, the outlier data points are flagged as invalid and may not be used in the modeling analyses.

In addition, the model-ready emissions files used in CMAQ will be evaluated and compared against the planning inventory totals. Although deviations between the model-ready and planning inventories are expected due to temporal adjustments (e.g., month-of-year and day-of-week) and adjustments based on meteorology (e.g., evaporative emissions from motor vehicles and biogenic sources), any excessive deviation will be investigated to ensure the accuracy of the temporal and meteorology based adjustments. If determined to be scientifically implausible, then the adjustments which led to the deviation will be investigated and updated based on the best available science.

Similar to the quality control of the modeling emissions inventory, the chemical boundary conditions derived from the global CTM model will be evaluated to ensure that no errors were introduced during the processing of the data (e.g., during vertical interpolation of the global model data to the regional model vertical structure or mapping of the chemical species). Any possible errors will be evaluated and addressed if they are determined to be actual errors and not an artifact of the spatial and temporal dynamics inherent in the boundary conditions themselves.

6. METEOROLOGICAL MODEL PERFORMANCE

The complex interactions between the ocean-land interface, orographic induced flows from the mountain-valley topography, and the extreme temperature gradients between the ocean, delta regions, valley floor, and mountain ranges, make California one of the most challenging areas in the country to simulate using prognostic meteorological models. Although there is a long history of prognostic meteorological model applications in California (e.g., Bao et al., 2008; Hu at al., 2010; Jackson et al., 2006; Jin et al., 2010a, 2010b; Livingstone et al., 2009; Michelson et al., 2010; Seaman, Stauffer, and Lario-Gibbs, 1995; Stauffer et al., 2000; Tanrikulu et al., 2000), there is no single model configuration that works equally well for all years and/or seasons, which makes evaluation of the simulated meteorological fields critical for ensuring that the fields reasonably reproduce the observed meteorology for any given time period.

6.1 Ambient Data Base and Quality of Data

Observed meteorological data used to evaluate the WRF model simulations will be obtained from the Air Quality and Meteorological Information System (AQMIS) database, which is a web-based source for real-time and official air quality and meteorological data (www.arb.ca.gov/airqualitytoday/). This database contains surface meteorological observations from 1969-2016, with the data through 2013 having been fully quality assured and deemed official. In addition CARB also has quality-assured upper-air meteorological data obtained using balloons, aircraft, and profilers.

6.2 Statistical Evaluation

Statistical analyses will be performed to evaluate how well the WRF model captured the overall structure of the observed atmosphere during the simulation period, using wind speed, wind direction, temperature, and humidity. The performance of the WRF model against observations will be evaluated using the METSTAT analysis tool (Emery et al, 2001) and supplemented using statistical software tools developed at CARB. The model output and observations will be processed, and data points at each observational site for wind speed, wind direction, temperature, and moisture data will be extracted. The following values will be calculated: Mean Obs, Mean Model, Mean Bias (MB), Mean (Gross) Error (ME/MGE), Normalized Mean Bias (NMB), Root Mean Squared error (RMSE), and the Index Of Agreement (IOA) when applicable. Additional statistical analysis may also be performed.

The mathematical expressions for these quantities are:

$$\mathrm{MB} = \frac{1}{\mathrm{N}}\sum_{1}^{\mathrm{N}}(\mathrm{Model} - \mathrm{Obs}) \qquad (6\text{-}1)$$

$$\mathrm{ME} = \frac{1}{\mathrm{N}}\sum_{1}^{\mathrm{N}}\left|\mathrm{Model} - \mathrm{Obs}\right| \qquad (6\text{-}2)$$

$$\mathrm{NMB} = \frac{\sum_{1}^{\mathrm{N}}(\mathrm{Model} - \mathrm{Obs})}{\sum_{1}^{\mathrm{N}}\mathrm{Obs}} \times 100\%, \qquad (6\text{-}3)$$

$$\mathrm{RSME} = \sqrt{\frac{\sum_{1}^{\mathrm{N}}(\mathrm{Model} - \mathrm{Obs})^2}{\mathrm{N}}} \qquad (6\text{-}4)$$

$$IOA = 1 - \frac{\sum_{1}^{N}(Model - Obs)^2}{\sum_{1}^{N}\left[(Model - Obs) + (Model + Obs)\right]^2}, \qquad (6\text{-}5)$$

where, “*Model*” is the simulated values, “*Obs*” is the observed value, and *N* is the number of observations. These values will be tabulated and plotted for all monitoring sites within the air basin of interest, and summarized by subregion when there are distinct differences in the meteorology within the basin. Statistics may be compared to other prognostic model applications in California to place the current model performance within the context of previous studies. In addition to the statistics above, model performance may also be evaluated through metrics such as frequency distributions, time-series analysis, and wind-rose plots. Based on previous experience with meteorological simulations in California, it is expected that the analysis will show wind speed to be overestimated at some stations with a smaller difference at others. The diurnal variations of temperature and wind direction at most stations are likely to be captured reasonably well. However, the model will likely underestimate the larger magnitudes of temperature during the day and smaller magnitudes at night.

6.3 Phenomenological Evaluation

In addition to the statistical evaluation described above, a phenomenological based evaluation can provide additional insights as to the accuracy of the meteorological modeling. A phenomenological evaluation may include analysis such as determining the relationship between observed air quality and key meteorological parameters (e.g., conceptual model) and then evaluating whether the simulated meteorology and air quality is able to reproduce those relationships. Another possible approach would be to generate geopotential height charts at 500 and 850 mb using the simulated results and compare those to the standard geopotential height charts. This would reveal if the large-scale weather systems at those pressure levels were adequately simulated by the regional prognostic meteorology model. Another similar approach is to identify the larger-scale meteorological conditions associated with air quality events using the National Centers for Environmental Prediction (NCEP) Reanalysis dataset. These can then be visually compared to the simulated meteorological fields to determine whether those large-scale meteorological conditions were accurately simulated and whether the same relationships observed in the NCEP reanalysis are present in the simulated data.

7. PHOTOCHEMICAL MODEL PERFORMANCE

7.1 Ambient Data

Air quality observations are routinely made at state and local monitoring stations. Gas species and PM species are measured on various time scales (e.g., hourly, daily, weekly). The U.S. EPA guidance recommends model performance evaluations for the following gaseous pollutants: ozone (O_3), nitric acid (HNO_3), nitric oxide (NO), nitrogen dioxide (NO_2), peroxyacetyl nitrate (PAN), volatile organic compounds (VOCs), ammonia (NH_3), NO_y (sum of NO_x and other oxidized compounds), sulfur dioxide (SO_2), carbon monoxide (CO), and hydrogen peroxide (H2O2). The U.S. EPA recognizes that not all of these species are routinely measured (U.S. EPA, 2014) and therefore may not be available for evaluating every model application. Recognizing that $PM_{2.5}$ is a mixture, U.S. EPA recommends model performance evaluation for the following individual $PM_{2.5}$ species: sulfate (SO_4^{2-}), nitrate (NO_3^-), ammonium (NH_4^+), elemental carbon (EC), organic carbon (OC) or organic mass (OM), crustal, and sea salt constituent (U.S. EPA, 2014).

Table 7-1 lists the species for which routine measurements are generally available in 2012 and 2013. When quality assured data are available and appropriate for use, model performance for each species will be evaluated. Observational data will be obtained from the Air Quality and Meteorological Information System (AQMIS), which is a web-based source for real-time and official air quality and meteorological data (www.arb.ca.gov/airqualitytoday/). This database contains surface air quality observations from 1980-2016, with the data through 2014 having been fully quality assured and deemed official.

Table 7-1. Monitored species used in evaluating model performance.

Species	Sampling frequency
O_3	1 hour
NO	1 hour
NO_2	1 hour
NO_x	1 hour
CO	1 hour
SO_2	1 hour
Selected VOCs from the PAMS measurement	3 hours (not every day)
$PM_{2.5}$ measured using FRM[1]	24 hours (daily to one in six days)
$PM_{2.5}$ measured using FEM	Continuously
$PM_{2.5}$ Speciation sites	24 hours (not every day)
Sulfate ion	24 hours (not every day)
Nitrate ion	24 hours (not every day)
Ammonium ion	24 hours (not every day)
Organic carbon	24 hours (not every day)
Elemental carbon	24 hours (not every day)
Sea salt constituents	24 hours (not every day)

[1] Direct comparison between modeled and FRM $PM_{2.5}$ may not be appropriate because of various positive and negative biases associated with FRM measurement procedures.

These species cover the majority of pollutants of interest for evaluating model performance as recommended by the U.S. EPA. Other species such as H_2O_2, HNO_3, NH_3, and PAN are not routinely measured. During the DISCOVER-AQ field campaign, which took place in January and February 2013 in the SJV, aircraft sampling provided daytime measurements for a number of species (including HNO_3, NH_3, PAN, alkyl nitrates, and selected VOC species) that are not routinely measured. Modeled concentrations will be compared to aircraft measurements for these species, except for the gaseous HNO_3 measurements, which were contaminated by particulate nitrate (Dr. Chris Cappa, personal communication).

7.2 Statistical Evaluation

As recommended by U.S. EPA, a number of statistical metrics will be used to evaluate model performance for ozone, speciated and total $PM_{2.5}$, as well as other precursor species. These metrics may include mean bias (MB), mean error (ME), mean fractional bias (MFB), mean fractional error (MFE), normalized mean bias (NMB), normalized mean error (NME), root mean square error (RMSE), correlation coefficient (R^2), mean normalized bias (MNB), and mean normalized gross error (MNGE). The formulae for estimating these metrics are given below.

$$\mathrm{MB} = \frac{1}{\mathrm{N}}\sum_{1}^{\mathrm{N}}(\mathrm{Model} - \mathrm{Obs}) \tag{7-1}$$

$$\mathrm{ME} = \frac{1}{\mathrm{N}}\sum_{1}^{\mathrm{N}}\left|\mathrm{Model} - \mathrm{Obs}\right| \tag{7-2}$$

$$\mathrm{MFB} = \frac{2}{\mathrm{N}}\sum_{1}^{\mathrm{N}}\left(\frac{\mathrm{Model} - \mathrm{Obs}}{\mathrm{Model} + \mathrm{Obs}}\right)\times 100\%, \tag{7-3}$$

$$\mathrm{MFE} = \frac{2}{\mathrm{N}}\sum_{1}^{\mathrm{N}}\left(\frac{\left|\mathrm{Model} - \mathrm{Obs}\right|}{\mathrm{Model} + \mathrm{Obs}}\right)\times 100\%, \tag{7-4}$$

$$\mathrm{NMB} = \frac{\sum_{1}^{N}(\mathrm{Model} - \mathrm{Obs})}{\sum_{1}^{N}\mathrm{Obs}} \times 100\%, \tag{7-5}$$

$$\mathrm{NME} = \frac{\sum_{1}^{N}|\,\mathrm{Model} - \mathrm{Obs}\,|}{\sum_{1}^{N}\mathrm{Obs}} \times 100\%, \tag{7-6}$$

$$\mathrm{RSME} = \sqrt{\frac{\sum_{1}^{N}(\mathrm{Model} - \mathrm{Obs})^2}{N}} \tag{7-7}$$

$$R^2 = \left(\frac{\sum_{1}^{N}((\mathrm{Model} - \overline{\mathrm{Model}}) \times (\mathrm{Obs} - \overline{\mathrm{Obs}}))}{\sqrt{\sum_{1}^{N}(\mathrm{Model} - \overline{\mathrm{Model}})^2 \sum_{1}^{N}(\mathrm{Obs} - \overline{\mathrm{Obs}})^2}}\right)^2 \tag{7-8}$$

$$\mathrm{MNB} = \frac{1}{N}\sum_{1}^{N}\left(\frac{\mathrm{Model} - \mathrm{Obs}}{\mathrm{Obs}}\right) \times 100\%, \tag{7-9}$$

$$\mathrm{MNGE} = \frac{1}{N}\sum_{1}^{N}\left(\frac{|\mathrm{Model} - \mathrm{Obs}|}{\mathrm{Obs}}\right) \times 100\%. \tag{7-10}$$

where, “Model” is the simulated mixing ratio, “$\overline{\mathrm{Model}}$” is the simulated mean mixing ratio, “Obs” is the observed value, “$\overline{\mathrm{Obs}}$” is the mean observed value, and “N” is the number of observations.

In addition to the above statistics, various forms of graphics will also be created to visually examine and compare the model predictions to observations. These will include time-series plots comparing the predictions and observations, scatter plots for comparing the magnitude of the simulated and observed mixing ratios, box plots to summarize the time series data across different regions and averaging times, as well as frequency distributions. For $PM_{2.5}$ the so called “bugle plots” of MFE and MFB from Boylan and Russell (2006) will also be generated. The plots described above will be created for paired observations and predictions over time scales dictated by the averaging frequencies of observations (i.e., hourly, daily, monthly, seasonally) for the species of interest. Together, they will provide a detailed view of model performance during different time periods, in different sub-regions, and over different concentrations and mixing ratio levels.

7.3 Comparison to Previous Modeling Studies

Previous U.S. EPA modeling guidance (U.S. EPA, 1991) utilized “bright line” criteria for the performance statistics that distinguished between adequate and inadequate model performance. In the latest modeling guidance from U.S. EPA (U.S EPA, 2014) it is now recommended that model performance be evaluated in the context of similar modeling studies to ensure that the model performance approximates the quality of those studies. The work of Simon et al. (2012) summarized photochemical model performance for studies published in the peer-reviewed literature between 2006 and 2012 and this work will form the basis for evaluating the modeling utilized in the attainment demonstration.

7.4 Diagnostic Evaluation

Diagnostic evaluations are useful for investigating whether the physical and chemical processes that control ozone and $PM_{2.5}$ formation are correctly represented in the modeling. These evaluations can take many forms, such as utilizing model probing tools like process analysis, which tracks and apportions ozone mixing ratios in the model to various chemical and physical processes, or source apportionment tools that utilize model tracers to attribute ozone formation to various emissions source sectors and/or geographic regions. Sensitivity studies (either “brute-force” or the numerical Direct Decoupled Method) can also provide useful information as to the response exhibited in the modeling to changes in various input parameters, such as changes to the emissions inventory or boundary conditions. Due to the nature of this type of analysis, diagnostic evaluations can be very resource intensive and the U.S. EPA modeling guidance acknowledges that air agencies may have limited resources and time to perform such analysis under the constraints of a typical SIP modeling application. To the extent possible, some level of diagnostic evaluation will be included in the model attainment demonstration for this SIP.

In addition to the above analysis, the 2013 DISCOVER-AQ field campaign in the SJV offers a unique dataset for additional diagnostic analysis that is not available in other areas, in particular, the use of indicator ratios in determining the sensitivity of secondary $PM_{2.5}$ to its limiting precursors. As an example, the ratio between free ammonia (total ammonia – 2 x sulfate) and total nitrate (gaseous + particulate) was proposed by Ansari and Pandis (1998) as an indicator of whether ammonium nitrate formation is limited by NO_x or ammonia emissions. The DISCOVER-AQ dataset will be utilized to the extent possible to investigate $PM_{2.5}$ precursor sensitivity in the SJV as well as analysis of upper measurements and detailed ground level AMS measurements (Young et al., 2016).

8. ATTAINMENT DEMONSTRATION

The U.S. EPA modeling guidance (U.S. EPA, 2014) outlines the approach for utilizing models to predict future attainment of the 0.075 ppm 8-hour ozone standard. Consistent with the previous modeling guidance (U.S. EPA, 2007) utilized in the most recent 8-hour ozone (2007), annual $PM_{2.5}$ (2008), and 24-hour $PM_{2.5}$ (2012) SIPs, the current guidance recommends utilizing modeling in a relative sense. A detailed description of how models are applied in the attainment demonstration for both ozone and $PM_{2.5}$, as prescribed by U.S. EPA modeling guidance, is provided below.

8.1 Base Year Design Values

The starting point for the attainment demonstration is with the observational based DV, which is used to determine compliance with the standard at any given monitor. The DV for a specific monitor and year represents the three-year average of the annual 4th highest 8-hour ozone mixing ratio, 98th percentile of the 24-hour $PM_{2.5}$ concentration, or annual average $PM_{2.5}$ concentration, depending on the standard, observed at the monitor. For example, the 8-hr O_3 DV for 2012 is the average of the observed 4th highest 8-hour ozone mixing ratio from 2010, 2011, and 2012.

The U.S. EPA recommends using an average of three DVs to better account for the year-to-year variability inherent in meteorology. Since 2012 has been chosen as the base year for projecting DVs to the future, site-specific DVs will be calculated for the three three-year periods ending in 2012, 2013, and 2014 and then these three DVs will be averaged. This average DV is called a weighted DV (in the context of this SIP, the weighted DV will also be referred to as the reference year DV or DV_R). Table 8-1 illustrates how the weighted DV is calculated.

Table 8-1. Illustrates the data from each year that are utilized in the DV calculation for that year (DV Year), and the yearly weighting of data for the weighted DV calculation (or DV_R). "obs" refers to the observed metric (8-hr O_3, 24-hour $PM_{2.5}$, or annual average $PM_{2.5}$).

DV Year	**Years Averaged for the DV (4th highest observed 8-hr O_3, 98th percentile 24-hour $PM_{2.5}$, or annual average $PM_{2.5}$)**				
2012	2010	2011	2012		
2013		2011	2012	2013	
2014			2012	2013	2014
Yearly Weightings for the Weighted DV Calculation					
2012-2014 Average	$DV_R = \frac{obs_{2010} + (2)obs_{2011} + (3)obs_{2012} + (2)obs_{2013} + obs_{2014}}{9}$				

8.2 Base, Reference, and Future Year Simulations

Projecting the weighted DVs to the future requires three photochemical model simulations as described below:

1. ***Base Year Simulation***
   The base year simulation for 2012 or 2013 is used to assess model performance (i.e., to ensure that the model is reasonably able to reproduce the observed ozone mixing ratios). Since this simulation will be used to assess model performance, it is essential to include as much day-specific detail as possible in the emissions inventory, including, but not limited to hourly adjustments to the motor vehicle and biogenic inventories based on observed local meteorological conditions, known wildfire and agricultural burning events, and exceptional events such as the Chevron refinery fire in 2012.

2. ***Reference Year Simulation***
   The reference year simulation is identical to the base year simulation, except that certain emissions events which are either random and/or cannot be projected to the future are removed from the emissions inventory. These include wildfires and events such as the 2012 Chevron refinery fire.

3. ***Future Year Simulation***
   The future year simulation is identical to the reference year simulation, except that the projected future year anthropogenic emission levels are used rather than the reference year emission levels. All other model inputs (e.g., meteorology, chemical boundary conditions, biogenic emissions, and calendar

for day-of-week specifications in the inventory) are the same as those used in the reference year simulation.

The base year simulation is solely used for evaluating model performance, while the reference and future year simulations are used to project the weighted DV to the future as described in subsequent sections of this document.

8.3 Relative Response Factors

As part of the model attainment demonstration, the fractional change in ozone or $PM_{2.5}$ between the model future year and model reference year are calculated for each monitor location. These ratios, called “relative response factors” or RRFs, are calculated based on the ratio of modeled future year ozone or $PM_{2.5}$ to the corresponding modeled reference year ozone or $PM_{2.5}$ (Equation 8-1).

$$\text{RRF} = \frac{\text{average } (O_3 \text{ or } PM_{2.5})_{\text{future}}}{\text{average } (O_3 \text{ or } PM_{2.5})_{\text{reference}}} \qquad (8\text{-}1)$$

8.3.1 8-hour Ozone RRF

For 8-hour ozone, the modeled maximum daily average 8-hour (MDA8) ozone is used in calculating the RRF. These MDA8 ozone values are based on the maximum simulated ozone within a 3x3 array of cells surrounding the monitor (Figure 8-1). The future and base year ozone values used in RRF calculations are paired in space (i.e., using the future year MDA8 ozone value at the same grid cell where the MDA8 value for the reference? year is located within the 3x3 array of cells). The days used to calculate the average MDA8 for the reference and future years are inherently consistent, since the same meteorology is used to drive both simulations.

Not all modeled days are used to calculate the average MDA8 ozone from the reference and future year simulations. The form of the 8-hour ozone NAAQS is such that it is geared toward the days with the highest mixing ratios in any ozone season (i.e., the 4th highest MDA8 ozone). Therefore, the modeled days used in the RRF calculation should also reflect days with the highest ozone levels. As a result, the current U.S. EPA guidance (U.S. EPA, 2014) suggests using the top 10 modeled days when calculating the RRF. Since the relative sensitivity to emissions changes (in both the model and real world) can vary from day-to-day due to meteorology and emissions (e.g., temperature dependent emissions or day-of-week variability) using the top 10 days ensures that the calculated RRF is robust and stable (i.e., not overly sensitive to any single day used in the calculation).

When choosing the top 10 days, the U.S. EPA recommends beginning with all days in which the simulated reference MDA8 is >= 60 ppb and then calculating RRFs based on the top 10 high ozone days. If there are fewer than 10 days with MDA8 ozone >= 60 ppb then all days >= 60 ppb are used in the RRF calculation, as long as there are at least 5 days used in the calculation. If there are fewer than 5 days >= 60 ppb, an RRF cannot be calculated for that monitor. To ensure that only modeled days which are consistent with the observed ozone levels are used in the RRF calculation, the modeled days are further restricted to days in which the reference MDA8 ozone is within ± 20% of the observed value at the monitor location.

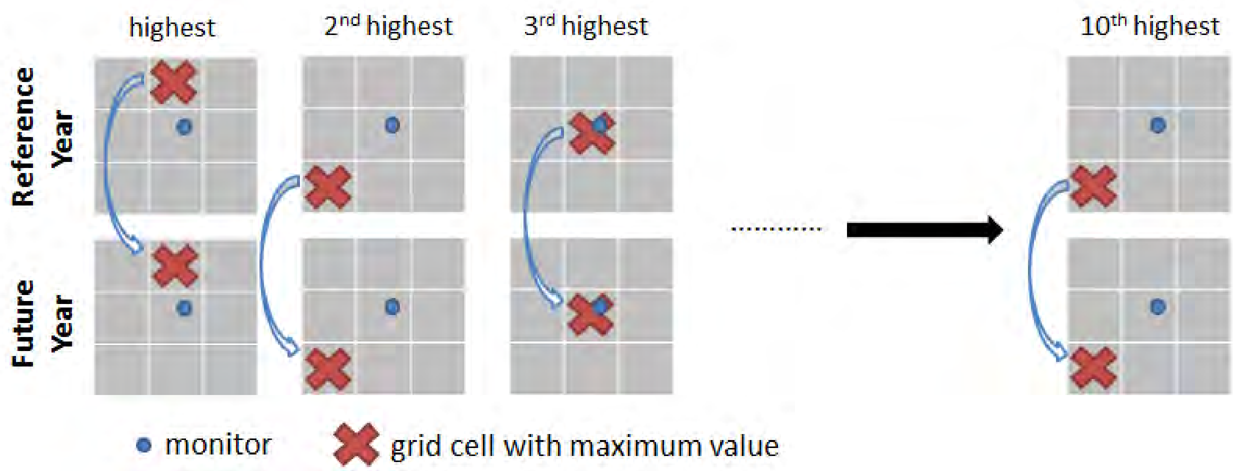

Figure 8-1. Example showing how the location of the MDA8 ozone for the top ten days in the reference and future years are chosen.

8.3.2 Annual and 24-hour $PM_{2.5}$ RRF

The U.S. EPA (2014) guidance requires RRFs for both the annual and 24-hour $PM_{2.5}$ attainment tests be calculated on a quarterly basis (January-March, April-June, July-September, and October-December) and for each $PM_{2.5}$ component (sulfate, nitrate, ammonium, organic carbon, elemental carbon, particle bound water, salt, and other primary inorganic components).

For annual $PM_{2.5}$, the quarterly RRFs are based on modeled quarterly mean concentrations for each component, where the concentrations are averaged over the 9 model grid cells within the 3x3 array of grid cells surrounding each monitor. For the 24-hour $PM_{2.5}$ attainment test, the quarterly RRFs are calculated based on the average for each component over the top 10% of modeled days (or the top nine days per quarter) with the highest total 24-hour average $PM_{2.5}$ concentration. Peak $PM_{2.5}$ values are selected and averaged using the $PM_{2.5}$ concentration simulated at the single grid cell containing the monitoring site for calculating the 24-hour $PM_{2.5}$ RRF (as opposed to the 3x3 array average used in the annual $PM_{2.5}$ RRF calculation).

8.4 Future Year Design Value Calculation

8.4.1 8-hour Ozone

For 8-hour ozone, a future year DV at each monitor is calculated by multiplying the corresponding reference year DV by the site-specific RRF from Equation 8-1 (Equation 8-2).

$$DV_F = DV_R \times RRF \tag{8-2}$$

where,
DV_F = future year DV,
DV_R = reference year DV, and
RRF = the site specific RRF from Equation 8-1

The resulting future year DVs are then compared to the 8-hour ozone NAAQS to demonstrate whether attainment will be reached under the future emissions scenario utilized in the future year modeling. A monitor is considered to be in attainment of the 8-hour ozone standard if the estimated future DV does not exceed the level of the standard.

8.4.2 Annual and 24-hour $PM_{2.5}$

8.4.2.1 Sulfate, Adjusted Nitrate, Derived, Water, Inferred Carbonaceous Material Balance Approach (SANDWICH) and Potential Modifications

Federal Reference Method (FRM) $PM_{2.5}$ mass measurements provide the basis for the attainment/nonattainment designations. For this reason it is recommended that the FRM data be used to project future air quality and progress towards attainment. However, given the complex physicochemical nature of $PM_{2.5}$, it is necessary to consider individual $PM_{2.5}$ species as well. While the FRM measurements give the mass of the bulk sample, a method for apportioning this bulk mass to individual $PM_{2.5}$ components is the first step towards determining the best emissions controls strategies to reach NAAQS levels in a timely manner.

The FRM measurement protocol finds its roots in the past epidemiological studies of health effects associated with $PM_{2.5}$ exposure. It is upon these studies that the NAAQS are based. The FRM protocol is sufficiently detailed so that results might be easily reproducible and involves the measurement of filter mass before and after sampling together with equilibrating at narrowly defined conditions. Filters are equilibrated for more than 24 hours at a standard relative humidity between 30 and 40% and temperature between 20 and 23 ºC. Due to the sampler construction and a lengthy filter equilibration period, FRM measurements are subjected to a number of known positive and negative artifacts. FRM measurements do not necessarily capture the $PM_{2.5}$ concentrations in the atmosphere and can differ substantially from what is measured by speciation monitors including the Speciation Trends Network (STN) monitors (see http://www.epa.gov/ttnamti1/specgen.html for more details). Nitrate and semi-volatile organic mass can be lost from the filter during the equilibration process, and particle bound water associated with hygroscopic species like sulfate provides a positive artifact. These differences present an area for careful consideration when one attempts to utilize speciated measurements to apportion the bulk FRM mass to individual species. Given that (1) attainment status is currently dependent upon FRM measurements and (2) concentrations of individual $PM_{2.5}$ species need to be considered in order to understand the nature of and efficient ways to ameliorate the $PM_{2.5}$ problem in a given region, a method has been developed to speciate bulk FRM $PM_{2.5}$ mass with known FRM limitations in mind. This method is referred to as the measured **S**ulfate, **A**djusted **N**itrate, **D**erived **W**ater, **I**nferred **C**arbonaceous material balance approach or "SANDWICH" (Frank, 2006). SANDWICH is based on speciated measurements from other (often co-located) samplers, such as those from STN, and the known sampling artifacts of the FRM. The approach strives to provide mass closure, reconciliation between speciated and bulk mass concentration measurements, and the basis for a connection between observations, modeled $PM_{2.5}$ concentrations, and the air quality standard (U.S. EPA, 2014).

The main steps in estimating the $PM_{2.5}$ composition are as follows:

(1) Calculate the nitrate retained on the FRM filter using hourly relative humidity and temperature together with the STN nitrate measurements,

The FRM does not retain all of the semi-volatile $PM_{2.5}$ mass, and at warmer temperatures, loss of particulate nitrate from filters has been commonly observed (Chow et al., 2005). In order to estimate how much nitrate is retained on the FRM filter, simple thermodynamic equilibrium relations may be used. Necessary inputs include 24-hour average nitrate measurements and hourly temperature and relative humidity data. Frank (2006) suggests the following methodology for estimating retained nitrate. For each hour *i* of the day, calculate the dissociation constant, K_i from ambient temperature and relative humidity (RH).

For RH < 61%:

$$\ln(K_i) = 118.87 - (24084/T_i) - 6.025 \times \ln(T_i),$$

where, T_i is the hourly temperature in Kelvins and K_i is in nanobars.

For RH ≥ 61%, K_i is replaced by:

$$K_i' = [P_1 - P_2(1-a_i) + P_3(1-a_i)^2] \times (1-a_i)^{1.75} \times K_i,$$

where, a_i is “fractional” relative humidity and

$$\ln(P_1) = -135.94 + 8763/T_i + 19.12 \times \ln(T_i),$$
$$\ln(P_2) = -122.65 + 9969/T_i + 16.22 \times \ln(T_i),$$
$$\ln(P_3) = -182.61 + 13875/T_i + 24.46 \times \ln(T_i).$$

Using this information, calculate the nitrate retained on the filter as:

$$\text{Retained Nitrate} = \text{STN nitrate} - 745.7/T_R \times (\kappa - \gamma) \times \frac{1}{24}\sum_{i=1}^{24}\sqrt{K_i},$$

where, T_R is the daily average temperature for the sampled air volume in Kelvin, K_i is the dissociation constant for NH_4NO_3 at ambient temperature for hour i, and $(\kappa - \gamma)$ relates to the temperature rise of the filter and vapor depletion from the inlet surface and is assumed to have a value equal to one (Hering and Cass, 1999).

(2) Calculate quarterly averages for retained nitrate, sulfate, elemental carbon, sea salt, and ammonium,

(3) Calculate particle bound water using the concentrations of ammonium, sulfate, and nitrate, using an equilibrium model like the Aerosol Inorganic Model (AIM) or a polynomial equation derived from model output

Under the FRM filter equilibration conditions, hygroscopic aerosol will retain its particle bound water (PBW) and be included in the observed FRM $PM_{2.5}$ mass. PBW can be calculated using an equilibrium model like the Aerosol Inorganics Model (AIM). AIM requires the concentrations of ammonium, nitrate, sulfate, and estimated H^+ as inputs. In addition to inorganic concentrations, the equilibration conditions are also necessary model inputs. In this case, a temperature of 294.15 K and 35% RH is recommended. Alternatively, for simplification, a polynomial regression equation may be constructed by fitting the calculated water concentration from an equilibrium model and the concentrations of nitrate, ammonium, and sulfate. The AIM model will be used for more accurate calculation of PBW.

(4) Add 0.5 μg/m^3 as blank mass, and

(5) Calculate organic carbon mass (OCMmb) by difference, subtracting all inorganic species (including blank mass) from the $PM_{2.5}$ mass.

Other components that may be represented on the FRM filter include elemental carbon, crustal material, sea salt, and passively collected mass. Depending on location certain species may be neglected (e.g., sea salt for inland areas).

While carbonaceous aerosol may make up a large portion of airborne aerosol, speciated measurements of carbonaceous PM are considered highly uncertain. This is due to the large number of carbon compounds in the atmosphere and the measurement uncertainties associated with samplers of different configurations. In the SANDWICH approach, organic carbonaceous mass is calculated by difference. The sum of all nonorganic carbon components will be subtracted from the FRM $PM_{2.5}$ mass to estimate the mass of organic carbon.

After having calculated the species concentrations as outlined above, we will calculate the percentage contribution of each species to the measured FRM mass (minus the blank concentration of 0.5 μg/m^3) for each quarter of the years represented by the speciated data. Note that blank mass is kept constant at 0.5 μg/m^3 between the base and future years, and future year particle bound water needs to be calculated for the future year values of nitrate, ammonium, and sulfate.

8.4.2.2 Estimation of Species Concentrations at Federal Reference Method (FRM) Monitors that Lack Speciation Data

Speciation data from available STN (speciation) sites will be used to speciate the FRM mass for all FRM sites. For those sites not collocated with STN monitors, surrogate speciation sites will be determined based on proximity and evaluation of local emissions or based on similarity in speciation profiles if such data exists (e.g., such as the speciated data collected in the SJV during CRPAQS (Solomon and Magliano, 1998)).

8.4.2.3 Speciated Modeled Attainment Test (SMAT)

Following U.S. EPA modeling guidance (U.S. EPA, 2014), the model attainment test for the annual $PM_{2.5}$ standard will be performed with the following steps.

Step 1: For each year used in the DV calculation, determine the observed quarterly mean $PM_{2.5}$ and quarterly mean composition for each monitor by multiplying the monitored quarterly mean concentration of FRM derived $PM_{2.5}$ by the fractional composition of $PM_{2.5}$ species for each quarter.

Step 2: Calculate the component specific RRFs at each monitor for each quarter as described in section 8.3.2.

Step 3: Apply the component specific RRFs to the quarterly mean concentrations from Step 1 to obtain projected quarterly species estimates.

Step 4: Calculate future year annual average $PM_{2.5}$ estimates by summing the quarterly species estimates at each monitor and then compare to the annual $PM_{2.5}$ NAAQS. If the projected average annual arithmetic mean $PM_{2.5}$ concentration is ≤ the NAAQS, then the attainment test is passed.

For the 24-hour $PM_{2.5}$ standard, the attainment test is performed with the following steps (U.S. EPA, 2014):

Step 1: Determine the top eight days with the highest observed 24-hour $PM_{2.5}$ concentration (FRM sites) in each quarter and year used in the DV calculation (a total of 32 days per year), and calculate the 98th percentile value for each year.

Step 2: Calculate quarterly ambient species fractions on "high" $PM_{2.5}$ days for each of the major $PM_{2.5}$ component species (i.e., sulfate, nitrate, ammonium, elemental carbon, organic carbon, particle bound water, salt, and blank mass). The "high" days are represented by the top 10% of days in each quarter. Depending on the sampling frequency, the number of days captured in the top 10% would range from three to nine. The species fractions of $PM_{2.5}$ are calculated using the "SANDWICH" approach which was described previously. These quarter-specific fractions along with the FRM $PM_{2.5}$ concentrations are then used to calculate species concentrations for each of the 32 days per year determined in Step 1.

Step 3: Apply the component and quarter specific RRF, described in Section 8.3.2, to observed daily species concentrations from Step 2 to obtain future year concentrations of sulfate, nitrate, elemental carbon, organic carbon, salt, and other primary $PM_{2.5}$.

Step 4: Calculate the future year concentrations for the remaining $PM_{2.5}$ components (i.e., ammonium, particle bound water, and blank mass). The future year ammonium is calculated based on the calculated future year sulfate and nitrate, using a constant value for the degree of neutralization of sulfate from the ambient data. The future year particle bound water is calculated from the AIM model.

Step 5: Sum the concentration of each of the species components to calculate the total $PM_{2.5}$ concentration for each of the 32 days per year and at each site. Sort the 32 days for each site and year, and calculate the 98^{th} percentile value corresponding to each year.

Step 6: Calculate the future DV at each site based on the 98^{th} percentile concentrations calculated in Step 5 and following the standard protocol for calculating DVs (see Table 8-1). Compare the future-year 24-hour DVs to the NAAQS. If the projected DV is ≤ the NAAQS, then the attainment test is passed.

8.4.2.4 Sensitivity Analyses

Model sensitivity analysis may be conducted if the model attainment demonstration does not show attainment of the applicable standard with the baseline future inventory, or for determining precursor sensitivities and inter-pollutant equivalency ratios. For both ozone and $PM_{2.5}$, the sensitivity analysis will involve domain wide fractional reductions of the appropriate anthropogenic precursor emissions using the future year baseline emissions scenario as a starting point. In the event that the model attainment demonstration does not show attainment for the applicable standard, it is important to know the precursor limitation to assess the level of emissions controls needed to attain the standard.

In order to identify what combinations of precursor emissions reductions is predicted to lead to attainment, a series of modeling sensitivity simulations with varying degrees of precursor reductions from anthropogenic sources are typically performed. These sensitivity simulations are identical to the baseline future year simulation discussed earlier except that domain-wide fractional reductions are applied to future year anthropogenic precursor emission levels and a new future year DV is calculated. The results of these sensitivity simulations are plotted on isopleth diagrams, which are also referred to as carrying capacity diagrams. The isopleths provide an estimate of the level of emissions needed to demonstrate attainment and thereby inform the development of a corresponding control strategy.

For ozone, this would likely entail reducing anthropogenic NO_x and VOC emissions in 25% increments including cross sensitivities (e.g., 0.75 x NO_x + 1.00 x VOC; 1.00 x NO_x + 0.75 x VOC; 0.75 x NO_x + 0.75 x VOC; 0.5 x NO_x + 1.00 x VOC; ….). Typically, a full set of sensitivities would include simulations for 25%, 50%, and 75% reduction in NO_x and VOC, along with the cross sensitivities (for a total of 16 simulations including the future base simulation). After DVs are calculated for each new sensitivity simulation, an ozone isopleth (or carrying capacity diagram) as a function of NO_x and VOC emissions is generated and used to estimate the additional NO_x and VOC emission reductions needed to attain the standard. The approach for $PM_{2.5}$ is similar, except that additional precursor emissions must be considered. Typically, the precursors considered for $PM_{2.5}$ would include anthropogenic NO_x, SO_x, VOCs, NH_3, as well as direct $PM_{2.5}$ emissions (Chen et al., 2014). Cross sensitivities for generating $PM_{2.5}$ carrying capacity diagrams would be conducted with respect to NO_x, which would include the following precursor pairs: NO_x vs. primary $PM_{2.5}$, NO_x vs. VOC, NO_x vs. NH_3, and NO_x vs. SO_x.

In addition to the $PM_{2.5}$ carrying capacity simulations, precursor sensitivity modeling may be conducted for determining the significant precursors to $PM_{2.5}$ formation and for developing inter-pollutant equivalency ratios. These simulations would follow a similar approach to the carrying capacity simulations described above, but would involve only a single sensitivity simulation for each precursor, where emissions of that precursor are reduced between 30% and 70% from the future base year. The “effectiveness” of reducing a given species can be quantified at each FRM monitor as the change in µg $PM_{2.5}$ (i.e., change in DV) per ton of precursor emissions (corresponding to the 15% change in emissions). Equivalency ratios between $PM_{2.5}$ precursors (i.e., NO_x, SO_x, VOCs, and NH_3) and primary $PM_{2.5}$ will be determined by dividing primary $PM_{2.5}$ effectiveness by the precursors’ effectiveness.

8.5 Unmonitored Area Analysis

The unmonitored area analysis is used to ensure that there are no regions outside of the existing monitoring network that could exceed the NAAQS if a monitor was present at that location (U.S. EPA, 2014). The U.S. EPA recommends combining spatially interpolated DV fields with modeled gradients for the pollutant of interest (e.g. Ozone and $PM_{2.5}$) and grid-specific RRFs in order to generate gridded future year gradient adjusted DVs. The spatial Interpolation of the observed DVs is done only within the geographic region constrained by the monitoring network, since extrapolating to outside of the monitoring network is inherently uncertain. This analysis can be done using the Model Attainment Test Software (MATS) (Abt, 2014); however this software is not open source and comes as a precompiled software package. To maintain transparency and flexibility in the analysis, in-house R codes (https://www.r-project.org/) developed at CARB will be utilized in this analysis. The basic steps followed in the unmonitored area analysis for 8-hour ozone and annual/24-hour $PM_{2.5}$ are described below.

8.5.1 8-hour Ozone

In this section, the specific steps followed in 8-hr ozone unmonitored area analysis are described briefly:

Step 1: At each grid cell, the top-10 modeled maximum daily average 8-hour ozone mixing ratios from the reference year simulation will be averaged, and a gradient in this top-10 day average between each grid cell and grid cells which contain a monitor will be calculated.

Step 2: A single set of spatially interpolated 8-hr ozone DV fields will be generated based on the observed 5-year weighted base year 8-hr ozone DVs from the available monitors. The interpolation is done using normalized inverse distance squared weightings for all monitors within a grid cell’s Voronoi Region (calculated with the R tripack library; https://cran.r-project.org/web/packages/tripack/README), and adjusted based on the gradients between the grid cell and the corresponding monitor from Step 1.

Step 3: At each grid cell, the RRFs are calculated based on the reference- and future-year modeling following the same approach outlined in Section 8.3, except that the +/- 20% limitation on the simulated and observed maximum daily average 8-hour ozone is not applicable because observed data do not exist for grid cells in unmonitored areas.

Step 4: The future year gridded 8-hr ozone DVs are calculated by multiplying the gradient-adjusted interpolated 8-hr ozone DVs from Step 2 with the gridded RRFs from Step 3

Step 5: The future-year gridded 8-hr ozone DVs (from Step 4) are examined to determine if there are any peak values higher than those at the monitors, which could potentially cause violations of the applicable 8-hr ozone NAAQS.

8.5.2 Annual $PM_{2.5}$

The unmonitored area analysis for the annual $PM_{2.5}$ standard will include the following steps:

Step 1: At each grid cell, the annual average $PM_{2.5}$ (total and by species) will be calculated from the future year simulation, and a gradient in the annual averages between each grid cell and grid cells which contain a monitor will be calculated.

Step 2: The annual future year speciated $PM_{2.5}$ DVs will be obtained for each design site as described in section 8.4. For each grid cell, the monitors within its Voronoi Region will be identified, and the speciated $PM_{2.5}$ values are then interpolated using normalized inverse distance squared weightings for all monitors within a grid cell's Voronoi Region. The interpolated speciated $PM_{2.5}$ fields are then adjusted based on the appropriate gradients from Step 1.

Step 3: The concentration of each of the component $PM_{2.5}$ species are summed to calculate the total $PM_{2.5}$ concentration (or DV) for each grid cell.

Step 4: The future year gridded annual average $PM_{2.5}$ estimates are then compared to the annual $PM_{2.5}$ NAAQS to determine compliance.

8.5.3 24-hour $PM_{2.5}$

The unmonitored area analysis for the 24-hour $PM_{2.5}$ standard will include the following steps:

Step 1: At each grid cell, the quarterly average of the top 10% of the modeled days for 24-hour $PM_{2.5}$ (total and by species for the same top 10% of days) will be calculated from the future year simulation, and a gradient in these quarterly speciated averages between each grid cell and grid cells which contain a monitor will be calculated.

Step 2: The 24-hour future year speciated $PM_{2.5}$ DVs will be obtained for each design site as described in section 8.4. For each grid cell, the monitors within its Voronoi Region will be identified, and the speciated $PM_{2.5}$ values are then interpolated using normalized inverse distance squared weightings for all monitors within a grid cell's Voronoi Region. The interpolated speciated $PM_{2.5}$ fields are then adjusted based on the appropriate gradients from Step 1.

Step 3: The concentration of each of the component $PM_{2.5}$ species are summed to calculate the total $PM_{2.5}$ concentration (or DV) for each grid cell.

Step 4: The future year gridded 24-hour average $PM_{2.5}$ estimates are then compared to the 24-hour $PM_{2.5}$ NAAQS to determine compliance.

The R codes used in this analysis will be made available upon request.

8.6 Banded Relative Response Factors for Ozone

The "Band-RRF" approach expands upon the standard "Single-RRF" approach for 8-hour ozone to account for differences in model response to emissions controls at varying ozone levels. The most recent U.S. EPA modeling guidance (U. S. EPA, 2014) accounts for some of these differences by focusing on the top ten modeled days, but even the top ten days may contain a significant range of ozone mixing ratios. The Band-RRF approach accounts for these differences more explicitly by grouping the simulated ozone into bands of lower, medium, and higher ozone mixing ratios. Specifically, daily peak 8-hour ozone mixing ratios for all days meeting model performance criteria (+/- 20% with the observations) can be stratified into 5 ppb increments from 60 ppb upwards (bin size and mixing ratio range may vary under different applications). A separate RRF is calculated for each ozone band following a similar approach as the standard Single-RRF. A linear regression is then fit to the data resulting in an equation relating RRF to ozone band. Similar to the Single-RRF, this equation is unique to each monitor/location.

The top ten days for each monitor, based on observed 8-hour ozone, for each year that is utilized in the DV calculation (see Table 8-1) is then projected to the future using the appropriate RRF for the corresponding ozone band. The top ten future days for each year are then re-sorted, the fourth highest 8-hour ozone is selected, and the future year DV is calculated in a manner consistent with the base/reference year DV calculation. More detailed information on the Band-RRF approach can be found in Kulkarni et al. (2014) and the 2013 SJV 1-hour ozone SIP (SJVUAPCD, 2013).

9. PROCEDURAL REQUIREMENTS

9.1 How Modeling and other Analyses will be Archived, Documented, and Disseminated

The computational burden of modeling the entire state of California and its sub-regions requires a significant amount of computing power and large data storage requirements. For example, there are over half a million grid cells in total for each simulation based on the Northern CA domain (192 x 192 cells in the lateral direction and 18 vertical layers). The meteorological modeling system has roughly double the number of grid cells since it has 30 vertical layers. Archiving of all the inputs and outputs takes several terabytes (TB) of computer disk space (for comparison, one single-layer DVD can hold roughly 5 gigabytes (GB) of data, and it would require ~200 DVDs to hold one TB). Please note that this estimate is for simulated surface-level pollutant output only. If three-dimensional pollutant data are needed, it would add a few more TB to this total. Therefore, transferring the modeling inputs/outputs over the internet using file transfer protocol (FTP) is not practical.

Interested parties may send a request for model inputs/outputs to Mr. John DaMassa, Chief of the Modeling and Meteorology Branch at the following address.

John DaMassa, Chief
Modeling and Meteorology Branch
Air Quality Planning and Science Division
Air Resources Board
California Environmental Protection Agency
P.O. Box 2815
Sacramento, CA 95814, USA

The requesting party will need to send an external disk drive(s) to facilitate the data transfer. The requesting party should also specify what input/output files are requested so that CARB can determine the capacity of the external disk drive(s) that the requester should send.

9.2 Specific Deliverables to U.S. EPA

The following is a list of modeling-related documents that will be provided to the U.S. EPA.

- The modeling protocol
- Emissions preparation and results
- Meteorology
    - Preparation of model inputs
    - Model performance evaluation
- Air Quality
    - Preparation of model inputs
    - Model performance evaluation
- Documentation of corroborative and weight-of-evidence analyses
- Predicted future year DVs
- Access to input data and simulation results

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APPENDIX F: Conceptual Model for the Imperial County 12 $\mu g/m^3$ Annual $PM_{2.5}$ Plan (2017)

November 13, 2017

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ACRONYMS

CARB – California Air Resources Board

DRI – Desert Research Institute

FEM – Federal Equivalent Method

FRM – Federal Reference Method

OC – Organic Carbon

PM – Particulate Matter

$PM_{2.5}$ – Particulate matter with aerodynamic diameter less than 2.5 µm

PM_{10} – Particulate matter with aerodynamic diameter less than 10 µm

SANDWICH – Sulfate, Adjusted Nitrate, Derived Water, Inferred Carbon Hybrid

SASS – Spiral Aerosol Speciation Sampler

SCERP – Southwest Consortium for Environmental Research and Policy

SCOS97 – South Coast Ozone Study

SIP – State Implementation Plan

SLAMS - State and Local Air Monitoring Stations

U.S. – United States

U.S. EPA – United States Environmental Protection Agency

VOC – Volatile Organic Carbon

1. TIMELINE OF THE PLAN

Table 1-1. Timeline for Completion of the Plan

Timeline	Action
Spring 2017	Emission Inventory Completed
Summer 2017	Modeling Completed
February 2017	District Hearing to consider the Draft Plan
March 2017	CARB Board Hearing to consider the Imperial Adopted Plan
April 2017	Plan submitted to U.S. EPA

2. DESCRIPTION OF THE CONCEPTUAL MODEL FOR THE NONATTAINMENT AREA

2.1 History of Field Studies in the Region

Field studies in the border region of Imperial County and Mexicali are limited, and the few studies that have been conducted were primarily focused on PM_{10} emissions and episodes, rather than $PM_{2.5}$ (Table 2-1). Nevertheless, these studies can provide useful information regarding the meteorological conditions that lead to elevated PM concentrations, transport patterns, as well as PM composition and sources contributing to the total PM burden. Many of these studies were conducted under the auspices of the Southwest Consortium for Environmental Research and Policy (SCERP), which was a university consortium that focused on environmental research in the U.S.-Mexican border region. SCERP was created by the U.S. Congress in 1990 and ended its operations in 2013.

The most relevant SCERP projects were two studies that focused on investigating low-wind/high PM episodes in the Imperial Valley. The studies concluded that the low-wind/high PM episodes in the border region (Calexico/Mexicali) are relatively common during winter months, but much less so during summer months. The episodes are driven by periodic, short-term (2-6 hour) periods of elevated PM, which usually occur in the evening. Multivariate analysis (principal component analysis, positive matrix factorization, and principal component regression) were applied to ambient PM measurements in the Calexico-Mexicali region, and showed that on both sides of the border, gasoline and diesel emissions, followed by trash burning, biomass burning, and road dust emissions were the predominant sources contributing to the organic carbon fraction of the measured PM.

A previous study conducted in the early 1990's, the Imperial/Mexicali Valley Cross-Border PM_{10} Transport Study, funded by U.S. EPA Region 9 and conducted by Desert Research Institute (DRI) researchers, showed that PM_{10} concentrations in Mexicali were consistently double or more compared to those observed only 12-km away in Calexico (Chow and Watson, 2001). In addition, PM_{10} concentrations in the border region were shown to be higher during southerly wind flow from Mexico compared to northerly wind flow, with approximately three times higher cross-border transport of PM_{10} under southerly flow conditions (Chow et al., 2000). Despite the difference in PM_{10} concentration between Calexico and Mexicali, source apportionment analysis of the data found that source contributions to PM_{10} were similar in both regions, with 70% coming from fugitive dust, 10-15% from motor vehicles, 4-8% from biomass burning or cooking, 2-3% from marine aerosol, 1.5-3% from secondary production of ammonium sulfate, and 1.5-2.5% from secondary ammonium nitrate (Chow et al., 2000).

Table 2-1. Field studies and analyses in the Imperial Valley/Mexicali region.

Year	Study	Significance
1981	The Impact of Transport from the South Coast Air Basin on Ozone Levels in the Southeast Desert Air Basin	Significant tracer concentrations were observed in the desert from SF_6 tracer releases throughout the Los Angeles air basin (Smith et al., 1983).
1992/93	Imperial/Mexicali Valley Cross-Border PM_{10} Transport Study	PM_{10} concentrations were found to be twice as high in Calexico compared to Mexicali, with similar source contributions, and the highest PM_{10} levels occurred under southerly flow conditions from Mexico (Chow et al., 2000; Chow and Watson, 2001; Watson and Chow, 2001).
1997	Southern California Ozone Study (SCOS97)	Measurements of VOCs in the Mexicali region indicate that the main source of non-methane VOC is from motor vehicles (Zielinska et al., 2001).
2001	Compilation, Summary, and Transport Analysis of Air Quality Data Collected Along the California/Mexico Border	Light and variable wind conditions often resulted in exceedances of air quality standards. Evidence suggests that local transport of primary pollutants from Mexicali to Calexico was significant (Hyslop et al., 2001).
2001-2004	Evaluation of PM Emissions from Vehicles in the Border Region	Busses and medium-duty trucks were found to be higher PM emitters than heavy-duty trucks or passenger vehicles. Mexican trucks and buses had higher average emission factors compared to U.S. trucks and buses, but results may not be statistically significant (Kelly et al., 2004).

2003-2006	Particulate Matter Emissions from Agricultural Burns in the Mexicali/Imperial Valley Region	On days with calm winds, agricultural burning contributed as much as 15% to the total PM_{10} mass (Kelly et al., 2006)
2005-2007	Investigation of Low-Wind/High Particulate Matter Episodes in the Imperial Valley/Mexicali Region	Concluded that these episodes are relatively common during winter months and are driven by short-term (2-6 hr) peaks in PM concentrations (Kelly et al., 2007).
2006-2008	Identifying Sources of Low-Wind/High Particulate Matter Episodes in the Imperial Valley-Mexicali Region	Sources contributing to these episodes were found to be mobile, trash and biomass burning, as well as windblown dust. Relative source contributions were similar on each side of the border (Kelly et al., 2008).

2.2 Description of the Ambient Monitoring Network

Imperial County is located in the southeast corner of California, and covers approximately 4,500 square miles with a population of around 175,000. The majority of the population and commercial activity/farming is located and occurs within the Imperial Valley, which covers around one quarter of the county and is bordered by the Salton Sea to the north, the Santa Rosa Mountain Range to the west, the Chocolate Mountains to the east, and Mexico to the south (Figure 2-1). Within the Valley, the three most populated cities are Calexico, El Centro, and Brawley, with populations that range from approximately 25,000 in Brawley to around 40,000 in Calexico and El Centro. To the south of Calexico across the U.S.-Mexico border is the Mexicali metropolitan region with a combined population of nearly one million. Mexicali has a strong agricultural and manufacturing economy, with year round agricultural activities.

Table 2-2 lists the five air quality monitoring sites within Imperial County and their geographic location, as well as the corresponding pollutants measured at each site. There are three FRM (Federal Reference Method) $PM_{2.5}$ monitors (Calexico Ethel, El Centro, and Brawley) and one speciated $PM_{2.5}$ monitor co-located at the Calexico Ethel site. The speciated fractions measured at Calexico Ethel will be used to speciate the total $PM_{2.5}$ measured at all three FRM monitors into their component species. A detailed discussion about the monitoring network and its adequacy can be found in the Valley's 2014 Ambient Air Monitoring Network Plan (https://www3.epa.gov/ttnamti1/files/networkplans/caimperial2014plan.pdf) and 2014 California Infrastructure SIP (http://www.arb.ca.gov/planning/sip/infrasip/docs/i-sip.pdf).

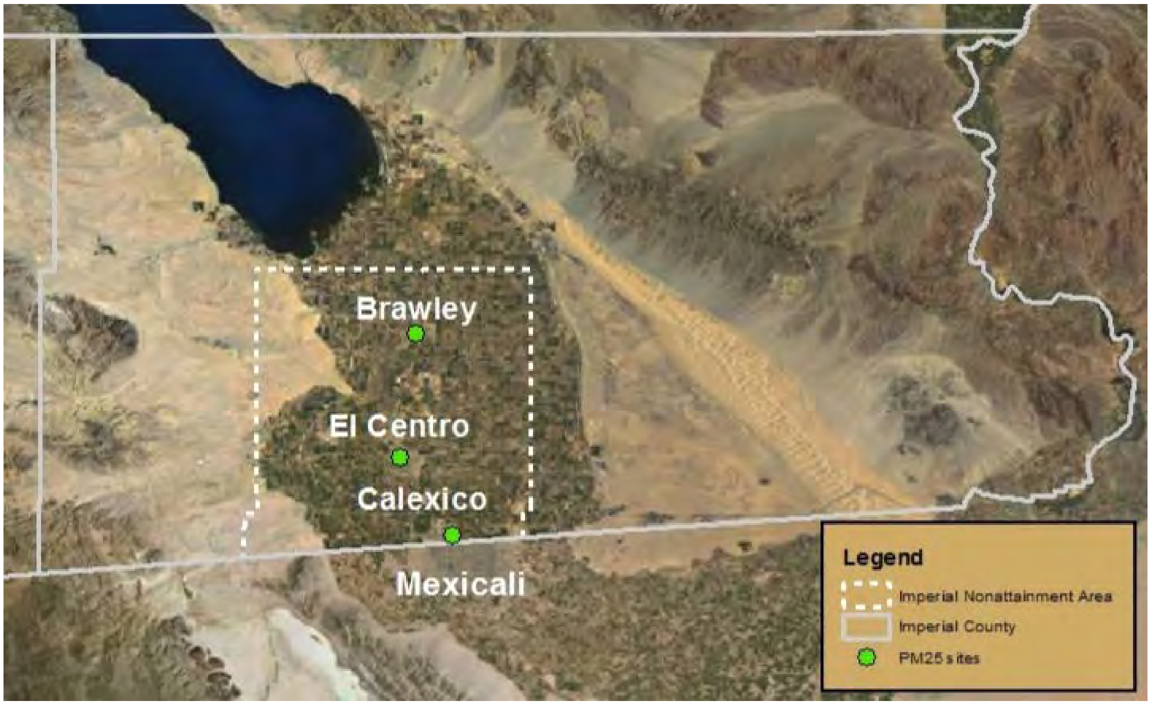

Figure 2-1. Map showing the borders of Imperial County, the nonattainment area, and Mexicali, as well as the location of the three $PM_{2.5}$ monitors within the nonattainment area.

Table 2-2. Imperial County monitoring sites.

Site ID (AQS/CARB)	Site	Particulate Matter ($PM_{2.5}$)				Gaseous			Location	
		FRM	FEM	non-FEM	Speciation	NO_x	Ozone	SO_2	Latitude	Longitude
Imperial County										
060254004 3186	Niland						X		33.21349	-115.54514
060254003 3143	Westmorland						X		33.03239	.115.62362
060250007 3675	Brawley	X							32.97831	-115.53904
060251003 2551	El Centro	X				X	X		32.79215	-115.56299
060250005 3135	Calexico Ethel	X	X	X	X	X		X	32.67618	-115.48307

2.3 $PM_{2.5}$ Air Quality Trends

Tables 2-3 and 2-4 show the annual average $PM_{2.5}$ concentration and the annual $PM_{2.5}$ design values (i.e., 3-year average), from 2001 to 2014, for the three $PM_{2.5}$ monitors in Imperial County. Based on the most recent trends, the Calexico Ethel monitor is the only monitor to exceed the annual $PM_{2.5}$ standard of 12 $\mu g/m^3$. Figure 2-2 shows the trend in peak county-wide annual average $PM_{2.5}$ concentration and 98^{th} percentile of the 24-hour $PM_{2.5}$ concentration, as well as the approximate number of days above the 24-hour standard (35 $\mu g/m^3$) in the valley from 1999 to 2014. Despite the steady decline in direct $PM_{2.5}$, NOx, and VOC emissions within the non-attainment area (Figure 2-3), the annual average $PM_{2.5}$ concentration within the county has remained relatively constant, while peak 24-hr $PM_{2.5}$ concentrations (98^{th} percentile of the annual data) have responded to emission reductions, declining from over 50 $\mu g/m^3$ in the early 2000's to under 40 $\mu g/m^3$ in 2014.

Table 2-3: Annual Average $PM_{2.5}$ ($\mu g/m^3$)

Monitoring Site	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Brawley	11.1	10.2	10.4	9	8.9	7.9	7.7	8.3	8	6.3	7.1	8.1	7.2	7.3
El Centro	8.9	9.3	9.2	9.7	9.4	8.8	8.5	8	8	6.6	7.5	7.5	7	6.6
Calexico Ethel	14.9	15.1	13.1	11.8	13.3	12.5	13	--	--	12.8	13.7	15.8	13.3	13.8

Table 2-4: Annual $PM_{2.5}$ Design Value (three year average, $\mu g/m^3$)

Monitoring Site	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Brawley	10.6	9.9	9.4	8.6	8.2	8.0	8.0	7.5	7.1	7.2	7.5	7.5
El Centro	9.1	9.4	9.4	9.3	8.9	8.4	8.2	7.5	7.4	7.2	7.3	7.0
Calexico Ethel	14.4	13.3	12.7	12.5	12.9	12.8	13.0	12.8	13.3	14.1	14.3	14.3

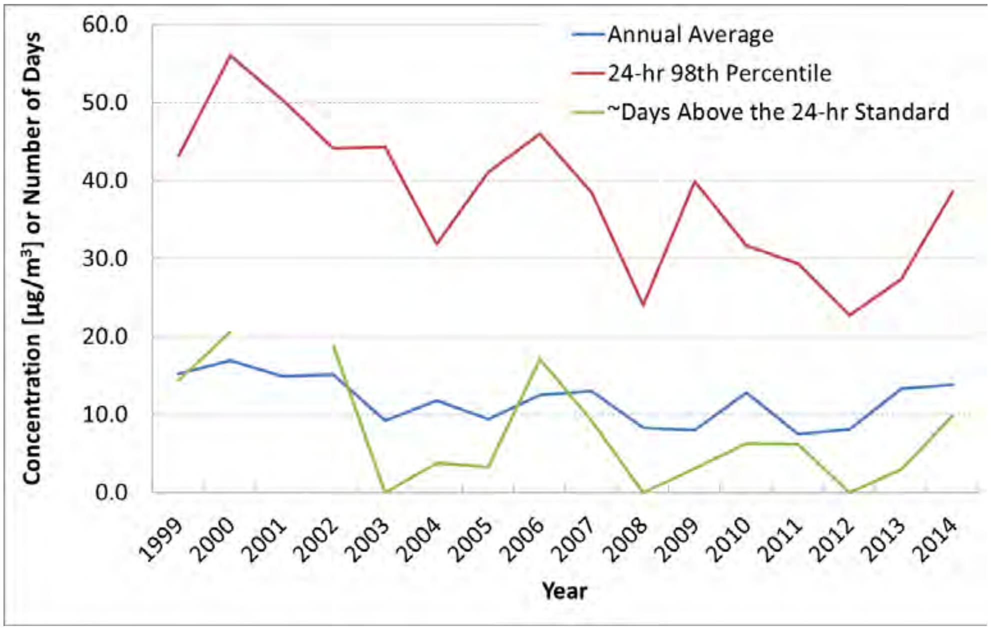

Figure 2-2. Trends in county-wide annual average, 24-hour 98th percentile $PM_{2.5}$, and approximate number of days above the 24-hour standard (http://www.arb.ca.gov/adam/index.html).

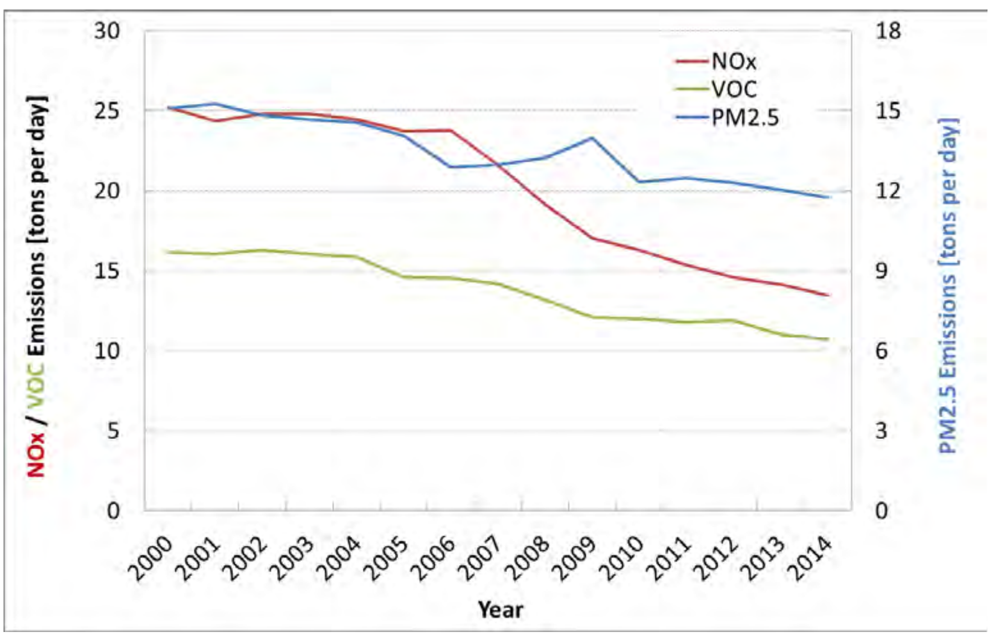

Figure 2-3. Imperial non-attainment area trends in $PM_{2.5}$, NO_x, and VOC emissions.

2.4 Major $PM_{2.5}$ Components

The only site collecting $PM_{2.5}$ chemical composition data in Imperial County is the Calexico Ethel site, which is part of the State and Local Air Monitoring Stations (SLAMS) network, and utilizes a Spiral Aerosol Speciation Sampler (SASS). Measurements from the SLAMS network are analyzed by CARB.

Figure 2-4 illustrates the annual average $PM_{2.5}$ composition from 2010-2012 measured at the Calexico Ethel monitor. Note that these fractions are based on speciated measurements that have been adjusted to estimate the $PM_{2.5}$ mass composition produced by the FRM measurements based on the SANDWICH (Sulfate, Adjusted Nitrate, Derived Water, Inferred Carbon Hybrid) material balance approach (Frank, 2006) and recommended by U.S. EPA guidance (U.S. EPA, 2014). On an annual basis, the organic carbon mass contributes the most to total $PM_{2.5}$ (~60%), followed by crustal material (18%), sulfate (8%), and elemental carbon (6%), with a negligible nitrate contribution of approximately one percent.

The speciated $PM_{2.5}$ fractions derived from the SANDWICH approach are inherently different from those derived directly from the speciated monitoring data. In particular, the SANDWICH methodology translates the speciated measurements to conditions on the FRM filter. This is necessary because the speciated and FRM measurements utilize different protocols/measurement techniques. This translation generally results in a lower ammonium nitrate fraction and higher organic carbon fraction compared to the direct speciated measuremnts (for more details, see Section 8.4.2.1 in the Modeling Protocol Appendix).

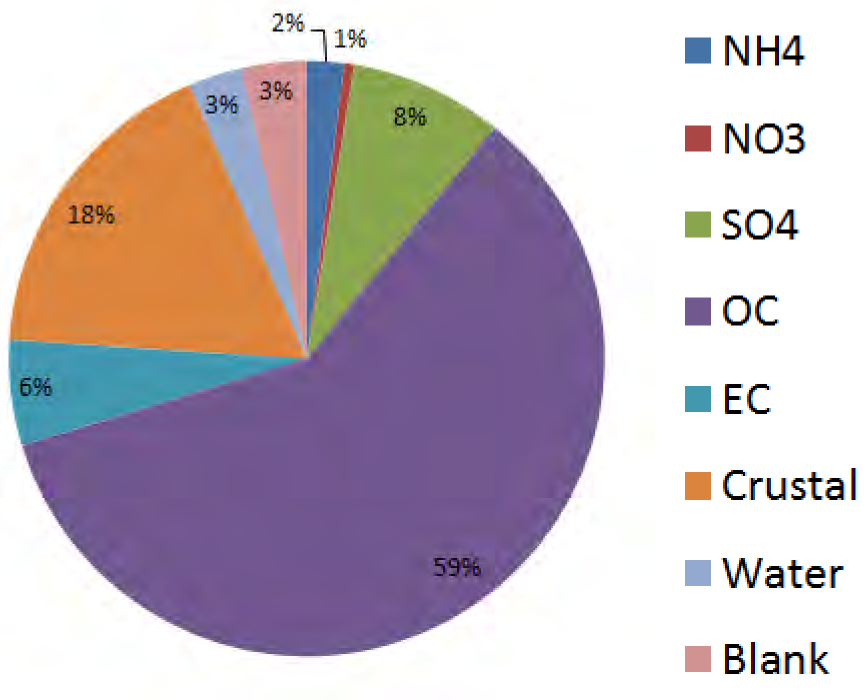

Figure 2-4. Three-year average (2010-2012) $PM_{2.5}$ composition (SANDWICH) at the Calexico Ethel monitoring site.

2.5 Seasonality of $PM_{2.5}$ and Meteorological Conditions Leading to Elevated $PM_{2.5}$

$PM_{2.5}$ concentrations in the Imperial Valley exhibit strong seasonal variability, with the highest concentrations generally occurring in the wintertime from November through February due to a confluence of meteorological conditions conducive to the transport and buildup of $PM_{2.5}$ from the Mexicali region (CARB, 2014), as well as wintertime sources of directly emitted $PM_{2.5}$. Figure 2-5 shows 24-hour $PM_{2.5}$ concentrations observed at the Calexico Ethel monitor from 2010 through 2014. As can be seen in the time series, peak $PM_{2.5}$ concentrations generally occur during winter months, but 24-hour average concentrations exceeding 20 µg/m^3 can occur anytime throughout the year.

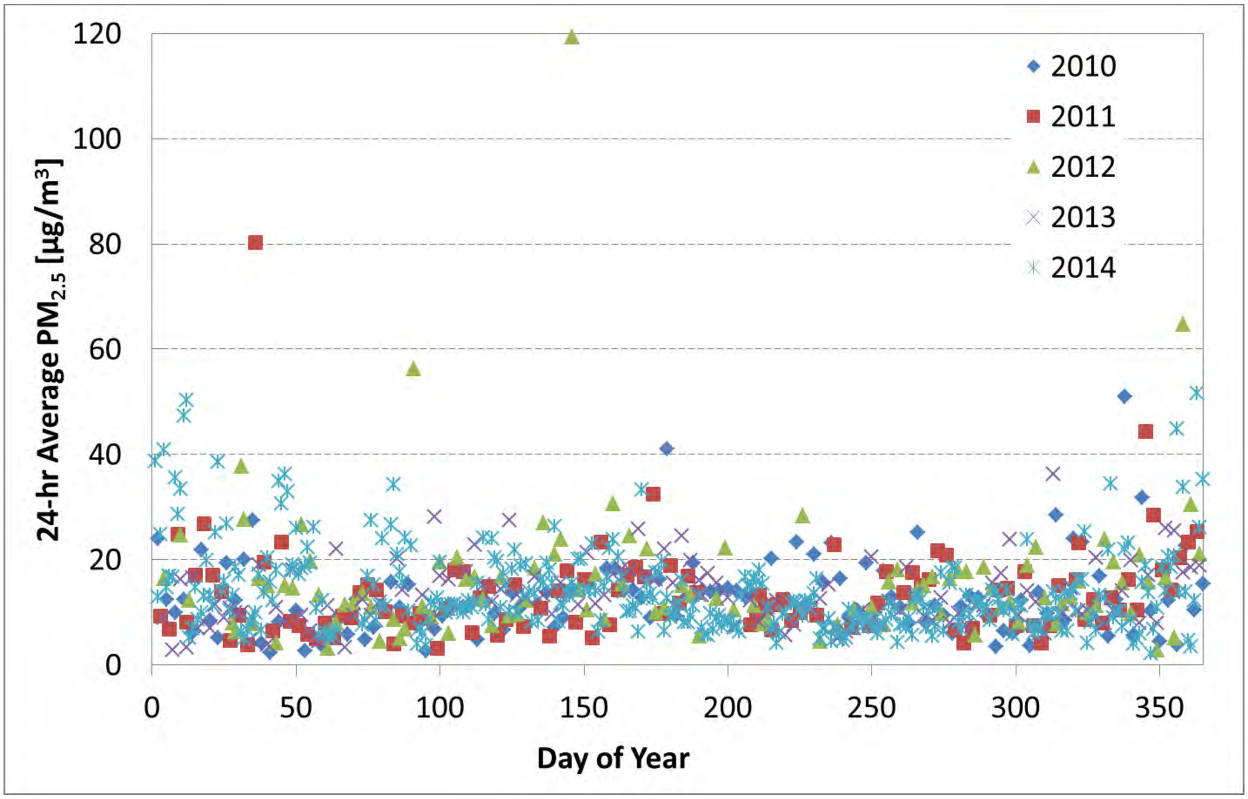

Figure 2-5. 24-hour $PM_{2.5}$ concentrations at the Calexico Ethel monitor from 2010-2014.

Elevated $PM_{2.5}$ episodes (exceeding the 24-hour $PM_{2.5}$ standard of 35 µg/m^3) in Calexico typically occur over a multi-day period where strong stagnant conditions persist, but can occur over shorter time periods. During these episodes, a concentration gradient is often present within the Valley, where concentrations decrease as one moves from the south to north away from the Mexicali source region. On peak $PM_{2.5}$ days, elemental $PM_{2.5}$ components, such as chromium and zinc, tend to be many times higher at Calexico than on non-exceedance days and compared to other areas of Imperial County. These elevated elemental $PM_{2.5}$ components are likely associated with combustion of refuse or other non-biomass materials, which is common in Mexicali, and are correlated well with the Mexicali source region and transport patterns on exceedance days (CARB, 2014).

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Appendix G

Modeling Emission Inventory for the PM2.5 State Implementation Plan in the Imperial County

Prepared by

California Air Resources Board

Imperial County Air Pollution Control District

Prepared for

United States Environmental Protection Agency Region IX

November 13, 2017

Contents

List of Tables

1. Development of $PM_{2.5}$ Emissions Inventories

Emission inputs for air quality modeling (commonly and interchangeably referred to as 'modeling inventories' or 'gridded inventories') have been developed by the California Air Resources Board (CARB) and district staff. These inventories support the different State Implementation Plans (SIPs) across California to meet various federal $PM_{2.5}$ standards. CARB maintains an electronic database of emissions and other useful information to generate aggregate emission estimates at the county, air basin and district level. This database is called the California Emission Inventory Development and Reporting System (CEIDARS). CEIDARS provides a foundation for the development of a more refined (hourly, grid-cell specific) set of emission inputs that are required by air quality models. The CEIDARS base year inventory is a primary input to the state's emission forecasting system, known as the California Emission Projection Analysis Model (CEPAM). CEPAM produces the projected emissions that are then gridded and serve as the emission input for the particulate matter models.

The following sections of this document describe how baseline emissions inventory estimates are prepared.

1.1. Inventory Coordination

The Air Resources Board convened the SIP Inventory Working Group (SIPIWG) to provide an opportunity and means for interested parties (CARB, districts, etc.) to discuss issues pertaining to the development and review of base year, future year, planning and gridded inventories to be used in SIP modeling. The group has met every four to six weeks since March 2013. Group participants included district staff from Bay Area, Butte, Eastern Kern, El Dorado, Feather River, Imperial, Northern Sierra, Placer, Sacramento, San Diego, San Joaquin, San Luis Obispo, South Coast, Ventura and Yolo-Solano.

Additionally, CARB established the SIPIWG Spatial Surrogate Sub-committee, which focused on improving input data to spatially disaggregate emissions at a more refined level needed for air quality modeling. Local air districts that participated included San Joaquin Valley APCD, South Coast AQMD, Ventura County APCD and Sacramento Metropolitan AQMD.

In addition to the two coordination groups described above, a great deal of work preceded this modeling effort through the Central California Air Quality Studies (CCAQS). CCAQS consisted of two studies: 1) the Central California Ozone Study (CCOS); and 2) the California Regional $PM_{10}/PM_{2.5}$ Air Quality Study (CRPAQS).

1.2. Background

California's emission inventory is an estimate of the amounts and types of pollutants emitted from thousands of industrial facilities, millions of motor vehicles and a myriad of emission sources such as consumer products and fireplaces. The development and maintenance of the emission inventory involves several agencies. This multi-agency effort includes: CARB, 35 local air pollution control and air quality management districts (Districts), regional transportation planning agencies (RTPAs), and the California Department of Transportation (Caltrans). The CARB is responsible for the compilation of the final statewide emission inventory, and for maintaining this information in CEIDARS. In addition to the statewide emission inventory, emissions from northern Mexico (Kwong, 2017) are also incorporated in the final emission inventory used for modeling. The final emission inventory reflects the best information available at the time.

The basic principle for estimating county-wide regulatory emissions is to multiply an estimated, per-unit emission factor by an estimate of typical usage or activity. For example, on-road motor vehicle emission factors are estimated for a specific vehicle type and applied to all applicable vehicles. The estimates are based on dynamometer tests of a small sample for a vehicle type. The activity for any given vehicle type is based on an estimate of typical driving patterns, number of vehicle starts, and typical miles driven. Assumptions are also made regarding typical usage; it is assumed that all vehicles of a certain vehicle type are driven under similar conditions in each region of the state.

Developing emission estimates for stationary sources involves the use of per unit emission factors and activity levels. Under ideal conditions, facility-specific emission factors are determined from emission tests for a particular process at a facility. A continuous emission monitoring system (CEMS) can also be used to determine a gas or particulate matter concentration or emission rate (U.S. EPA, 2016). More commonly, a generic emission factor is developed by averaging the results of emission tests from similar processes at several different facilities. This generic factor is then used to estimate emissions from similar types of processes when a facility-specific emission factor is not available. Activity levels from stationary sources are measured in terms such as the amount of product produced, solvent used, or fuel used.

The district reported or CARB estimated emissions totals are stored in the CEIDARS database for any given pollutant. Both criteria and toxic air pollutant emission inventories are stored in this complex database. These are typically annual average emissions for each county, air basin, and district. Modeling inventories for reactive organic gases (ROG) are estimated from total organic gases (TOG). Similarly, the modeling inventories for total particulate matter 10µ in diameter and smaller (PM_{10}) and total particulate matter 2.5µ in diameter and smaller ($PM_{2.5}$) are estimated from total particulate matter (PM). Details about chemical and size resolved speciation of emissions for modeling can be found in Section 0. Additional information on CARB emission inventories can be found at: http://www.arb.ca.gov/ei/ei.htm.

1.3. Inventory Year

The emission inventory scenarios used for air quality modeling must be consistent with U.S. EPA's Modeling guidance (U.S. EPA, 2014). Since changes in the emissions inventory can affect the calculation of the relative response factors (RRFs), the terms used in the preparation of the emission inventory scenarios must be clearly defined. In this document the following inventory definition will be used:

1.3.1. Reference Year (or Baseline) Modeling Inventory (2012): The baseline or reference year inventory is intended to be a representation of emission patterns occurring through the baseline design value period and the emission patterns expected in the future year. The 2012 reference year inventory represents typical average conditions and emission patterns through the 2012 design value period. This reference emissions inventory is not developed to capture day-specific emission characteristics. However, this baseline inventory includes temperature, relative humidity and solar insolation effects, for 2012.

1.4. Spatial Extent of Emission Inventories

The emissions model-ready files that are prepared for use as an input for the air quality model conform to the definition and extent of the grids shown in

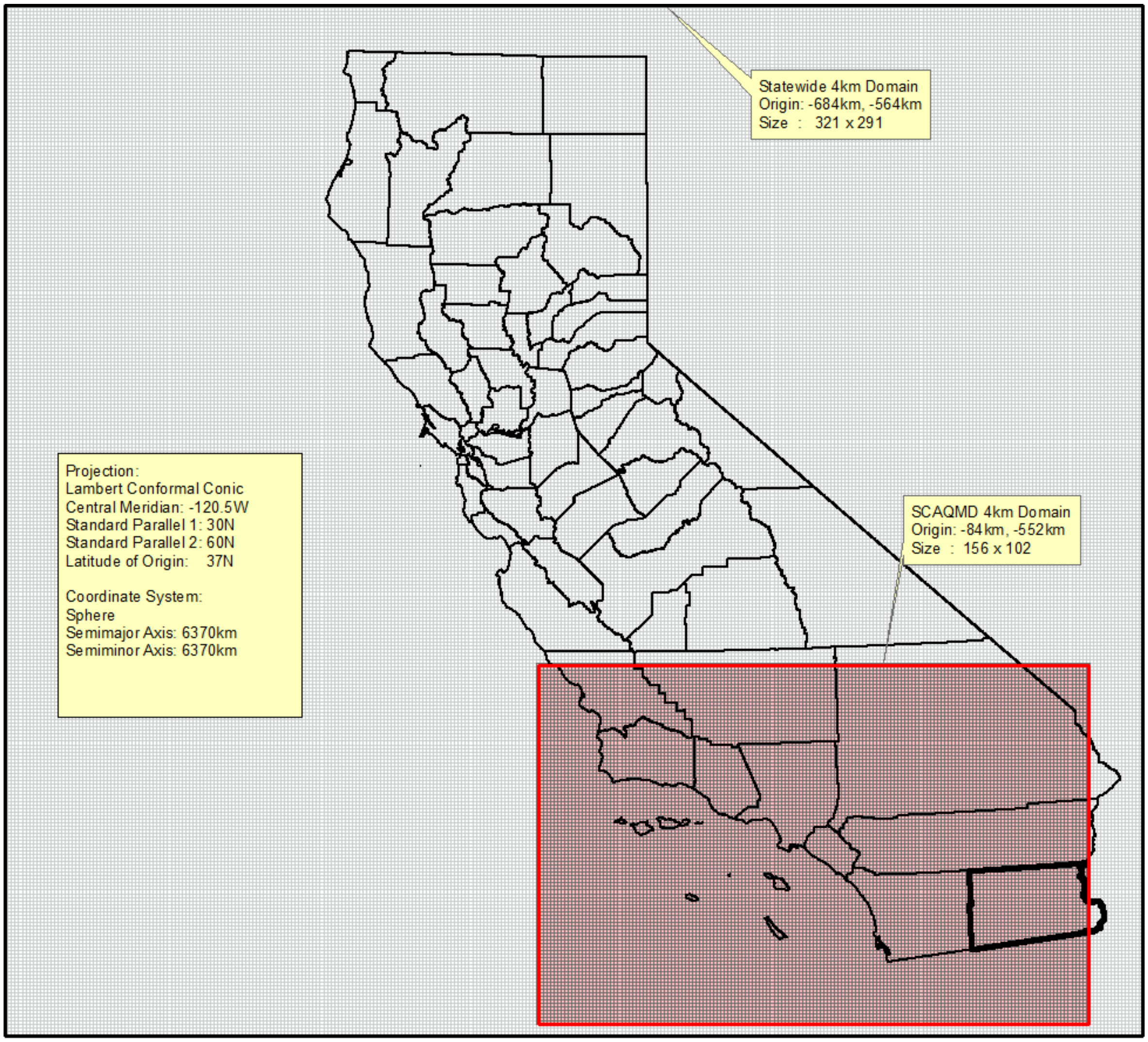


Figure 1.

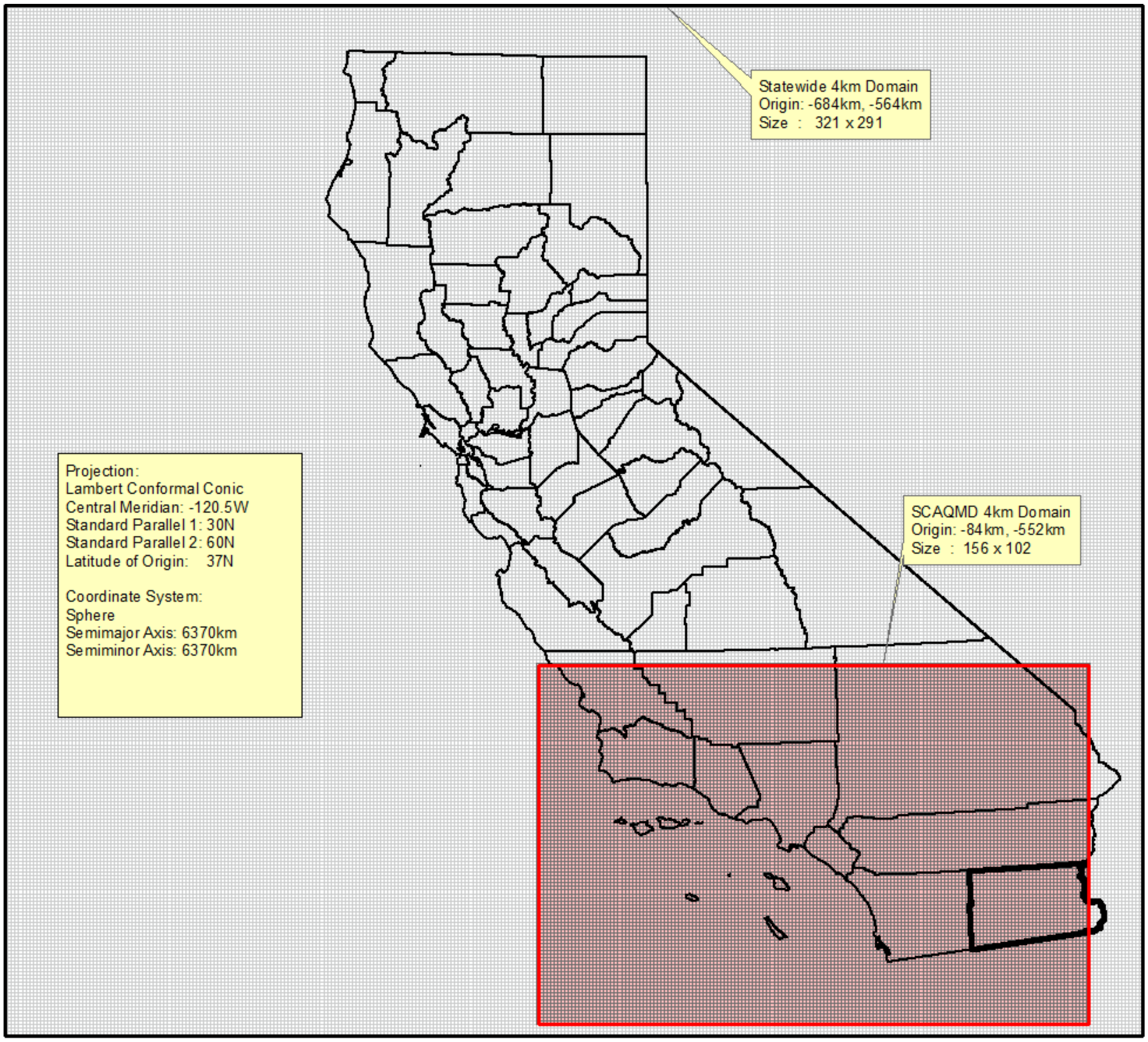


Figure 1 Spatial coverage and parameter summary of modeling domains

The domain uses a Lambert projection and assumes a spherical Earth. The emissions inventory grid uses a Lambert Conical Projection with two parallels. The parallels are at 30° and 60° N latitude, with a central meridian at 120.5° W longitude. The coordinate system origin is offset to 37° N latitude. The emissions inventory uses a grid with a spatial resolution of 4 km x 4 km. The state modeling domain extends entirely over California and 100 nautical miles west over the Pacific Ocean. A smaller 4km x 4km subdomain is used for the southern California region. The specifications for the statewide and southern California (SCAQMD) domains are summarized in Table 1.

Table 1 Modeling domain parameters

Parameter	Statewide domain	SCAQMD Subdomain
Map Projection	Lambert Conformal Conic	Lambert Conformal Conic
Datum	None (Clarke 1866 spheroid)	None (Clarke 1866 spheroid)
1st Standard Parallel	30.0° N	30.0° N
2nd Standard Parallel	60.0° N	60.0° N
Central Meridian	-120.5° W	-120.5° W
Latitude of projection origin	37.0° N	37.0° N
COORDINATE SYSTEM		
Units	Meters	Meters
Semi-major axis	6370 km	6370 km
Semi-minor axis	6370 km	6370 km
DEFINITION OF GRID		
Grid size	4km x 4km	4km x 4km
Number of cells	321 x 291 cells	156 x 102 cells
Lambert origin	(-684,000 m, -564,000 m)	(-84,000 m, -552,000 m)
Geographic center	-120.5° Lat and 37.0° Lon	-120.5° Lat and 37.0° Lon

2. Estimation of Baseline Year 2012 Modeling Inventory

The following sections describe the temporal and spatial distribution of emissions and how the different sectors of the modeling inventories are prepared.

2.1. Terminology

The terms “point sources” and “area sources” are often confused. Traditionally, these terms have had different meanings to the developers of emissions inventories and the developers of modeling inventories. Table 2 summarizes the difference in the terms. Both sets of terms are used in this document. In modeling terminology, “point sources” traditionally refer to elevated emission sources that exit from a stack and have an associated plume rise. While the current inventory includes emissions from stacks, <u>all</u> emission sources reported by the SJVAPCD associated with a facility are treated as potential elevated sources. The emissions processor calculates plume rise if appropriate; non-elevated sources are treated as ground-level sources. Examples of non-elevated emissions sources include gas dispensing facilities and storage piles.

“Area sources” refers collectively to area-wide sources, stationary-aggregated sources, and other mobile sources (including aircraft, trains, ships, and all off-road vehicles and equipment). That is, “area sources” are low-level sources from a modeling perspective.

Table 2 Inventory terms for emission source types

Modeling Term	Emission Inventory Term	Examples
Point	Stationary – Point Facilities	Stacks at Individual Facilities
Area	Off-Road Mobile	Construction Equipment, Farm Equipment, Trains, Recreational Boats
Area	Area-wide	Residential Fuel Combustion, Livestock Waste, Consumer Products, Architectural Coatings
Area	Stationary - Aggregated	Industrial Fuel Use
On-Road Motor Vehicles	On-Road Mobile	Cars and Trucks
Biogenic	Biogenic	Trees

The following sections describe in more detail the temporal, spatial and chemical disaggregation of the emissions inventory for point sources and area sources.

2.2. Temporal Distribution of Emissions

Emission inventories that are temporally and spatially resolved are needed for modeling purposes for the baseline modeling inventory. The temporal distribution of on-road emissions and biogenic emissions are discussed in Sections 3.4 and 3.5, respectively. How emissions are temporally distributed for the remaining sources (point, area and off-road mobile sources) is discussed below.

Emissions are adjusted temporally to represent variations by month, day of week and hour of day. Temporal data are stored in CARB’s emission inventory database. Each local air district assigns temporal data for all processes at each facility in their district to represent when emissions at each process occur. For example, emissions from degreasing may operate differently than a boiler. CARB or district staff also assigns temporal data for each area source category by county/air basin/district.

2.2.1. Monthly Variation: Emissions are adjusted temporally to represent variations by month. Some emission sources operate the same throughout a year. For example, a process heater at a refinery or a line haul locomotive likely operates the same month to month. Other emission categories, such as a tomato processing plant or use of recreational boats, vary significantly by season. CARB's emission inventory database stores the relative monthly fractional activity for each process, the sum of which is 100. Using an example of emission sources that typically operate the same over each season, emissions from refinery heaters and line haul locomotives would have a monthly fraction (throughput) of 8.33 for each month (calculated as 100/12 = 8.33). This is considered a flat monthly profile. To apply monthly variations to create a gridded inventory, the annual average day's emissions (yearly emissions divided by 365) is multiplied by the typical monthly throughput. For example, a typical monthly throughput in July for recreational boats of 15 results in about 1.8 times higher (15 / 8.33 = 1.8) emissions than a day with flat monthly profile.

2.2.2. Weekly Variation: Emissions are adjusted temporally to represent variations by day of week. Some operations are the same over a week, such as a utility boiler or a landfill. Many businesses operate only 5 days per week. Other emissions sources are similar on weekdays, but may operate differently on weekend days, such as architectural coatings or off-road motorcycles. To accommodate variations in days of the week, each process or emission category is assigned a days per week code or DPWK. Table 3 below shows the current DPWK codes and Table 11 in Appendix D shows additional DPWK codes used for agricultural-related emissions.

Table 3 Day of week variation factors

Code	WEEKLY CYCLE CODE DESCRIPTION	M	T	W	TH	F	S	S
1	One day per week	1	1	1	1	1	0	0
2	Two days per week	1	1	1	1	1	0	0
3	Three days per week	1	1	1	1	1	0	0
4	Four days per week	1	1	1	1	1	0	0
5	Five days per week - Uniform activity on week days; non on Saturday and Sunday	1	1	1	1	1	0	0
6	Six days per week - Uniform activity on week days; non on Saturday and Sunday	1	1	1	1	1	1	0
7	Seven days per week – Uniform activity every day Of the week	1	1	1	1	1	1	1
20	Uniform activity on Saturday and Sunday; No activity the remainder of the week	0	0	0	0	0	1	1
21	Uniform activity on Saturday and Sunday; No activity the remainder of the week	5	5	5	5	5	10	10
22	Uniform activity on week days; Reduced activity on weekends	10	10	10	10	10	7	4
23	Uniform activity on week days; Reduced activity on weekends (For onroad motor vehicles)	10	10	10	10	10	8	8
24	Uniform activity on week days; half as much activity on Saturday. Little activity on Sunday	10	10	10	10	10	5	1
25	Uniform activity on week days; one third as much on Saturday; little on Sunday	10	10	10	10	10	3	1
26	Uniform activity on week days; little activity on Saturday; no activity on Sunday	10	10	10	10	10	3	0
27	Uniform activity on week days; half as much activity on weekends	10	10	10	10	10	5	5
28	Uniform activity on week days; Five times as much activity on weekends	2	2	2	2	2	10	10
29	Uniform activity on Monday through Thursday; increased activity on Friday, Saturday, Sunday	8	8	8	8	10	10	10

2.2.3. Daily Variation: Emissions are adjusted temporally to represent variations by hour of day. Many emission sources occur 24 hours per day, such as livestock waste or a sewage treatment plant. Many businesses operate 8 hours per day. Other emissions sources vary significantly over a day, such as residential space heating or pesticide application. Each process or emission category is assigned an hours per day code or HPDY. Table 4 below shows the daily variation factors or current HPDY codes. Table 12 in Appendix D shows additional DPWK codes used for agricultural-related emissions.

Table 4 Daily variation factors

Code	CODE DESCRIPTION	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
--------	--------------------------------																								
1	1 HOUR PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
2	2 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
3	3 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
4	4 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
5	5 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
6	6 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
7	7 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
8	8 HOURS PER DAY - UNIFORM ACTIVITY FROM 8 A.M. TO 4 P.M. (NORMAL WORKING SHIFT)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
9	9 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
10	10 HOURS PER DAY	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
11	11 HOURS PER DAY	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
12	12 HOURS PER DAY	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0
13	13 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
14	14 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
15	15 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
16	16 HOURS PER DAY - UNIFORM ACTIVITY FROM 8 A.M. TO MIDNIGHT (2 WORKING SHIFTS)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
17	17 HOURS PER DAY	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
18	18 HOURS PER DAY	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
19	19 HOURS PER DAY	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
20	20 HOURS PER DAY	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
21	21 HOURS PER DAY	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
22	22 HOURS PER DAY	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
23	23 HOURS PER DAY	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
24	24 HOURS PER DAY - UNIFORM ACTIVITY DURING THE DAY	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
31	MAJOR ACTIVITY 5-9 P.M., AVERAGE DURING DAY, MINIMAL IN EARLY A.M.(GAS STATIONS)	3	1	1	1	1	1	1	5	5	5	5	5	5	5	5	5	5	10	10	10	10	7	7	3
33	MAX ACTIVITY 7-9 A.M. & 7-11 P.M.,AVERAGE DURING DAY, LOW AT NIGHT (RESIDENTIAL FUEL COMBUSTION)	2	2	2	2	2	2	2	10	10	6	6	5	5	5	5	5	5	5	5	10	10	10	10	2
34	ACTIVITY 1 TO 9 A.M.; NO ACTIVITY REMAINDER OF DAY (i.e. ORCHARD HEATERS)	0	8	8	8	8	10	10	10	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	MAX ACTIVITY 7 A.M. TO 1 A.M., REMAINDER IS LOW (i.e. COMMERCIAL AIRCRAFT)	10	1	1	1	1	1	1	8	8	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
37	ACTIVITY DURING DAYLIGHT HOURS; LESS CHANCE IN EARLY MORNING AND LATE EVENING	0	0	0	0	0	1	3	6	9	10	10	10	10	10	10	10	10	9	6	3	1	0	0	0
38	ACTIVITY DURING MEAL TIME HOURS (i.e. RESIDENTIAL COOKING)	0	0	0	0	0	2	6	6	2	2	1	2	4	4	2	1	1	3	10	8	7	6	1	0
50	PEAK ACTIVITY AT 7 A.M. & 4 P.M.; AVERAGE DURING DAY (ON-ROAD MOTOR VEHICLES)	1	1	1	1	1	1	6	10	6	5	5	5	5	5	5	6	10	8	6	4	1	1	1	1
51	ACTIVITY FROM 6 A.M. TO 12 P.M. (PETROLEUM DRY CLEANING)	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
52	MAJOR ACTIVITY FROM 6 A.M.-12 P.M., LESS FROM 12-7 P.M. (PESTICIDES)	0	0	0	0	0	1	6	10	10	10	10	10	6	3	3	3	3	4	4	0	0	0	0	0
53	ACTIVITY FROM 7 A.M. TO 12 P.M. (AGRICULTURAL AIRCRAFT)	0	0	0	0	0	0	0	2	2	2	2	2	1	0	0	0	0	0	0	0	0	0	0	0
54	UNIFORM ACTIVITY FROM 7 A.M. TO 9 P.M. (DAYTIME BIOGENICS)	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
55	UNIFORM ACTIVITY FROM 9 P.M. TO 7 A.M. (NIGHTIME BIOGENICS)	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
56	MAX ACTIVITY 8 A.M. TO 5 P.M, MINIMAL AT NIGHT & EARLY MORNING(CAN&COIL/METAL PARTS COATINGS)	0	0	0	0	1	1	2	3	10	10	10	10	10	10	10	10	9	1	1	1	1	1	1	1
57	MAX ACTIVITY 7 A.M. TO 2 P.M., MINIMAL AT EVENING AND MORNING HOURS (CONSTRUCTION EQUIPMENT ON HOT	0	0	0	0	0	1	6	10	10	10	10	10	10	9	8	4	2	1	1	0	0	0	0	0
58	MAX ACTIVITY 7 A.M. TO NOON.;REDUCED ACTIVITY NOON TO 6 P.M. (AUTO REFINISHING)	0	0	0	0	0	0	0	10	10	10	10	10	8	8	8	8	8	8	0	0	0	0	0	0
59	MAXIMUM ACTIVITY FROM 7:00 AM TO 3:00 PM; REDUCED ACTIVITY FROM 3:00 TO 6:00 PM.(CONSTRUCTION	0	0	0	0	0	0	2	10	10	10	10	10	10	10	10	7	3	1	1	0	0	0	0	0
60	MAXIMUM ACTIVITY FROM NOON TO 7:00 PM; REDUCED ACTIVITY EVENING AND MORNING HOURS (RECREATIONAL	0	0	0	0	0	0	0	2	4	6	7	9	10	10	10	10	10	10	10	7	5	3	1	0
81	MAX ACTIVITY 9 AM TO 3 PM; HALF THE ACTIVITY REMAINING HOURS (WASTE FROM DAIRY CATTLE)	7	6	6	5	4	4	4	5	7	8	9	10	10	10	7	3	3	3	4	4	5	6	7	7
82	ACTIVITY FROM 10 AM TO 9 PM RISING TO PEAK AT 3; NO ACTIVITY REMAINDER OF DAY (WASTE FROM POULTRY)	0	0	0	0	0	0	0	0	0	3	3	7	7	7	10	10	7	3	3	3	3	0	0	0
83	ACTIVITY FROM 9 AM TO 12 AM RISING TO PEAK AT 3; MINIMUM ACTIVITY REMAINDER OF DAY (WASTE FROM SWINE)	0	0	0	0	0	0	0	1	1	2	4	6	8	8	9	10	8	4	3	3	2	1	1	1
84	MAJOR ACTIVITY FROM 11AM TO 6PM; REDUCED OTHER HOURS (EVAP-COASTAL COUNTIES)	7	7	6	6	6	6	6	7	8	8	9	9	10	10	10	10	9	9	8	8	7	7	7	7
85	MAJOR ACTIVITY FROM 11AM TO 6PM; REDUCED OTHER HOURS (EVAP-NON-COASTAL COUNTIES)	5	5	5	5	4	4	5	5	6	7	8	9	9	10	10	10	9	9	8	7	6	6	6	5

2.3. Spatial Allocation

Once the baseline inventory is developed, the next step of modeling inventory development is to spatially allocate the emissions. Air quality modeling attempts to replicate the physical and chemical processes that occur in an inventory domain. Therefore, it is important that the physical location of emissions be specified as accurately as possible. Ideally, the actual location of all emissions would be known exactly. In reality, however, some categories of emissions would be virtually impossible to determine – for example, the actual amount and location of consumer products (e.g. deodorant) used every day. To the extent possible, the spatial allocation of emissions in a modeling inventory approximates as closely as possible the actual location of emissions.

Spatial allocation is typically accomplished by using spatial surrogates. These spatial surrogates are processed into spatial allocation factors in order to geographically distribute county-wide area source emissions to individual grid cells. Spatial surrogates are developed based on demographic, land cover and other data that exhibit patterns which vary geographically. The spatial surrogates have been updated over the years mainly by Sonoma Technology, Inc. (STI) (Funk, et al., 2001) who created a 2000 base year and various future years. Later, STI updated the underlying spatial data and developed new surrogates (Reid, et al., 2006) completing the project in 2008. CARB and districts have continued to update and improve many of the spatial surrogates and added new ones.

Three basic types of surrogate data were used to develop the original spatial allocation factors: land use and land cover; facility location; and demographic and socioeconomic data. Land use and land cover data are associated with specific land uses, such as agricultural harvesting or recreational boats. Facility locations are used for sources such as gas stations and dry cleaners. Demographic and socioeconomic data, such as population and housing, are associated with residential, industrial, and commercial activity (e.g. residential fuel combustion). To develop spatial allocation factors of high quality and resolution, local socioeconomic and demographic data were used where available for developing the baseline inventory. These data were available from local

Metropolitan Planning Organizations (MPO) or Regional Transportation Planning Agencies (RTPA), where they are used as inputs for travel demand models. In rural regions for which local data were not available, data from Caltrans' Statewide Transportation Model were used.

Since 2008, CARB and district staffs have continued to search for more recent or improved sources of data, since the underlying data used by STI were pre-recession. CARB and district staffs have updated many of the spatial surrogates and added many new ones.

- Updates to land use categories were made using the National Land Cover Database 2011 (Homer, et al., 2015).
- Many surrogates were updated using the locations from Dun & Bradstreet's Market Insight Database (Dun and Bradstreet, 2015). The types of sources were defined by SIC. Fourteen new surrogates were developed for industrial-related sources using SIC and whether manufacturing occurred at the facility.
- The surrogate for unpaved roads was updated using data obtained from the U.S. Census Bureau's TIGER (Topologically Integrated Geographic Encoding and Referencing). The data extract reflected 4WD roads, private roads, and unnamed roads in Imperial County.
- U.S. Census American Community Survey (FactFinder, 2011) data by census block were used to update residential fuel use.
- Sierra Research developed nine new surrogates related to agricultural activities (Anderson, et al., 2012) , some of which incorporated crop-specific factors.
- Seven new surrogates were developed using vessel traffic data, or Automatic Identification System (AIS) data, collected by the U.S. Coast Guard.
- A new surrogate was created to represent the location of construction equipment. The distribution is a combination of two sets of data: 90% change in "imperviousness" between 2006 and 2011 from NLCD 2011 and 10% road network. Impervious surfaces are mainly artificial structures such as pavements (roads, sidewalks, driveways and parking lots) that are covered by materials impenetrable to a satellite such as asphalt, concrete, brick, stone and rooftops.

- A new surrogate was compiled to distribute emissions from transport refrigeration units (TRU) from three sources: 65% distribution centers, 34% road network and 1% grocery stores / food processing facilities. Information on distribution centers were retrieved from ARBER, the CARB Equipment Registration software for the Transport Refrigeration Unit (TRU) ATCM and the Drayage Truck Regulation.

In all, a total of 99 unique surrogates are available for use. A summary of the spatial surrogates for which spatial allocation factors were developed is shown below in Table 5.

Table 5 Spatial Surrogates

Surrogate Name	**Surrogate Definition**
AEROSPACE	Spatial distribution of businesses involved in aerospace
Airports	Spatial locations of all airports
All_PavedRds	Spatial distribution of road network (all paved roads)
AutobodyShops	Locations of autobody repair and refinishing shops
CAFO	Spatial distribution of concentrated animal feeding operations
CANCOIL	Spatial distribution of businesses involved in can and coil operations
Cemeteries	Spatial locations of cemeteries
Comm_Airports	Spatial locations of commercial airports
COMPOST	Spatial distribution of composting
CONSTRUCTION_EQUIP	Spatial distribution of where construction equipment is used
Devplnd_HiDensity	Spatial distribution of developed land - low density, medium density and high density
Devplnd_LoDensity	Spatial distribution of developed land - open space (lowest density)
DREDGE	Locations of dredging
Drycleaners	Locations of dry cleaning facilities
DryLakeBeds	Locations of dry lake beds
Elev5000ft	Topological contours – areas above 5000 feet
Employ_Roads	Spatial distribution of total employment and road density (all paved roads)
FABRIC	Spatial distribution of businesses involved in fabric manufacturing
FERRIES	Locations of ferry ports and routes
FISHING_COMM	Locations of commercial fishing
Forestland	Spatial distribution of forest land
Fugitive_Dust	Spatial distribution of barren land
GAS_DISTRIBUTION	Location of gas pipelines
GAS_SEEP	Location of natural-occurring gas seeps
GasStations	Locations of gasoline service stations
GASWELL	Locations of gas wells
GolfCourses	Spatial locations of golf courses
HE_Sqft	Computed surrogate based on housing and employment (est. ft2 / person)
Hospitals	Spatial locations of hospitals
Housing	Spatial distribution of total housing
Housing_Autobody	Spatial distribution of housing and autobody refinishing shops
Housing_Com_Emp	Spatial distribution of total housing and commercial employment
Housing_Restaurants	Spatial distribution of total housing and restaurants/bakeries
Surrogate Name	Surrogate Definition
INDUSTRIAL	Spatial distribution of industrial businesses where manufacturing occurs (SIC<4000)
Industrial_Emp	Spatial distribution of industrial employment
InlandShippingLanes	Spatial distribution of major shipping lanes within bays and inland areas
Irr_Cropland	Spatial location of agricultural cropland
Lakes_Coastline	Locations of lakes, reservoirs, and coastline

Surrogate Name	Surrogate Definition
LAKES_RIVERS_RECBOAT	Locations of lakes, rivers and reservoirs where recreational boats are used
LANDFILLS	Locations of landfills
LANDPREP	Spatial distribution of dust from land preparation operations (e.g. tilling)
LINEHAUL	Spatial distribution of Class I rail network
LiveStock	Spatial distribution of cattle ranches, feedlots, dairies, and poultry farms
MARINE	Spatial distribution of businesses involved in marine
METALFURN	Spatial distribution of businesses involved in metal furniture
METALPARTS	Spatial distribution of businesses involved in metal parts and products
Metrolink_Lines	Spatial distribution of metrolink network
MILITARY_AIRCRAFT	Locations of landing strips on military bases
MILITARY_SHIPS	Locations of military ship activity
MILITARY_TACTICAL	Military bases where tactical equipment are used
MiltaryBases	Locations of military bases
NON_PASTURE_AG	Spatial distribution of farmland
NonIrr_Pastureland	Spatial location of pasture land
NonRes_Chg	Computed surrogate based on spatial distribution of non-residential areas
OCEAN_RECBOAT	Locations of recreational boat activity that can occur on the ocean and SF Bay
OIL_SEEP	Location of naturally-occurring oil seeps
OILWELL	Locations of oil wells (both onshore and offshore)
OTHERCOAT	Spatial distribution of businesses with SIC<4000 not included in another category
PAPER	Spatial distribution of businesses involved in paper
PASTURE	Spatial distribution of grazing land
PEST_ME_BR	Spatial distribution of methyl bromide pesticides
PEST_NO_ME_BR	Spatial distribution of non-methyl bromide pesticides
PLASTIC	Spatial distribution of businesses involved in plastic
Pop_ComEmp_Hos	Spatial distribution of hospitals, population and commercial employment
Population	Spatial distribution of population
Ports	Locations of shipping ports
POTWs	Coordinate locations of POTWs
PrimaryRoads	Spatial distribution of road network (primary roads)
PRINT	Spatial distribution of print businesses
Raillines	Spatial distribution of railroad network
RailYards	Locations of rail yards
Rds_HE	Calculated surrogate based on road densities and housing/employment (est. ft2 / person)
RefinieriesTankFarms	Coordinate locations of refineries and tank farms
Res_NonRes_Chg	Computed surrogate based on spatial distribution of residential and non-residential areas
ResGasHeating	Spatial distribution of homes using gas supplied by a utility as primary source of heating
Residential_Chg	Computed surrogate based on spatial distribution of residential areas
ResLPGHeat	Spatial distribution of homes using gas (bottled, tank or LP) as primary source of heating
ResNonResChg_IndEmp	Spatial distribution of industrial employment and residential/non-residential change
ResOilHeat	Spatial distribution of homes using fuel oil or kerosene as primary source of heating
Restaurants	Locations of restaurants
ResWoodHeating	Spatial distribution of homes using wood as primary source of heating
Surrogate Name	Surrogate Definition
SandandGravelMines	Locations of sand/gravel excavation and mining
Schools	Spatial locations of schools
SecondaryPavedRds	Spatial distribution of road network (secondary roads)
SEMICONDUCT	Spatial distribution of businesses involved in semiconductors
Ser_ComEmp_Sch_GolfC_Cem	Spatial distribution of service and commercial employment, schools, cemeteries, olf courses
Service_Com_Emp	Spatial distribution of service and commercial employment
Shiplanes	Spatial distribution of major shipping lanes
SILAGE	Spatial distribution of silage operations
SingleHousingUnits	Spatial distribution of single dwelling units
TRU	Spatial distribution of transport refrigeration units
TUG_TOW	Spatial distribution of tug and tow boats
UnpavedRds	Spatial distribution of road network (unpaved roads)
Wineries	Locations of wineries
WOOD	Spatial distribution of businesses using wood
WOODFURN	Spatial distribution of businesses involved in wood furniture

The following sections describe in more detail the type of spatial disaggregation used for each sector of the emissions inventory.

2.3.1. Spatial Allocation of Area Sources: Each area source category is assigned a spatial surrogate that is used to allocate emissions to a grid cell in CARB's 4km statewide modeling domain. Examples of surrogates include population, land use, and other data with known geographic distributions for allocating emissions to grid cells, as described above.

2.3.2. Spatial Allocation of Point Sources: Each point source is allocated to grid cells using the latitude and longitude reported for each stack. If there are no stack latitude and longitude, the facility coordinates are used. There are two types of point sources: elevated and non-elevated sources. Vertical distribution of elevated sources is allocated using the plume rise algorithm in the emissions processor, SMOKE (see Section 3.3), while non-elevated are allocated to the first layer. Most stationary point sources with existing stacks are regarded as elevated sources. Those without physical stacks that provide only latitude/longitude, such as airports or landfills, are considered non-elevated.

2.3.3. Spatial Allocation of Ocean going vessels (OGV): Ship emissions are allocated to the grids corresponding to the vessel traffic lanes in CARB's OGV model (ARB-PTSD, 2011) These traffic lanes were estimated from three different sources:

a. National Waterway Network
b. The Ship Traffic, Energy and Environment Model
c. Automated instrumentation system (AIS) telemetry data collected in 2007

2.3.4. Spatial Allocation of On-road Motor Vehicles: The spatial allocation of on-road motor vehicles is based on DTIM as described in Section 3.4.

2.3.5. Spatial Allocation of Biogenic Emissions: As described in Section 3.5, gridded biogenic emissions are derived using the Model of Emissions of Gases and Aerosols from Nature (MEGAN). MEGAN utilizes gridded emission factor and plant functional type data, adjusted by local meteorological conditions and satellite derived leaf area data, to estimate hourly biogenic emissions within each grid cell of the modeling domain. More details about MEGAN can be found at http://lar.wsu.edu/megan/.

2.3.6. Spatial Allocation of Residential Wood Combustion Emissions: As described in Section 3.6.4, the emissions from residential wood combustion were allocated spatially based on areas subject to residential wood curtailment (i.e. no-burn days) for each district.

The lighter red areas in Figure 2 show where emissions are reduced due to residential wood curtailment programs in three air districts.

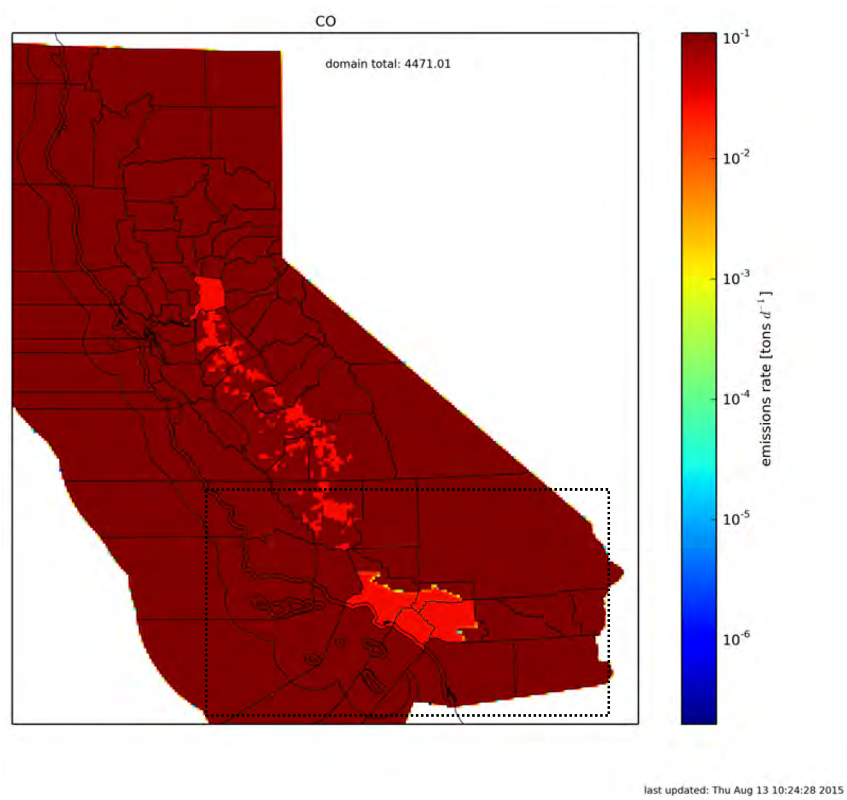


Figure 2 Map of residential wood curtailment areas

In the San Joaquin Valley, a reduction in emissions due to curtailment was only applied to areas where natural gas service is available (e.g. provided by a municipality) as reflected in Rule 4901 (October 2008 version of the rule). In the South Coast, emission reductions due to curtailment were applied to locations below 3000 feet, as stated in Rule 445. For Sacramento, curtailment was applied to all of Sacramento County per Rule 421.

2.4. Speciation Profiles

CARB's emission inventory lists the amount of pollutants discharged into the atmosphere by source in a certain geographical area during a given time period. It currently contains estimates for CO, NH_3, NOx, SOx, total organic gases (TOG) and particulate matter (PM). CO and NH3 are single species; NOx emissions are composed of NO, NO_2 and HONO; and SOx emissions are composed of SO_2 and SO_3. Emissions of TOG and PM for many sources can actually contain over hundreds of different chemical species, and speciation is the process of disaggregating these inventory pollutants into individual chemical species components or groups of species. CARB maintains and updates such species profiles for organic gases (OG) and PM for a variety of source categories.

Photochemical models simulate the physical and chemical processes in the lower atmosphere, and include all emissions of the important classes of chemicals involved in photochemistry. Organic gases emitted to the atmosphere are referred to as Total Organic Gas or TOG. TOG includes all organic compounds that can become airborne (through evaporation, sublimation, as aerosols, etc.), excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates and ammonium carbonate. TOG emissions reported in the ARB's emission inventory are the basis for deriving the Reactive Organic Gas (ROG) emission components, which are also reported in the inventory. ROG is defined as TOG minus ARB's exempt compounds (e.g., methane, ethane, various chlorinated fluorocarbons, acetone, perchloroethylene, volatile methyl siloxanes, etc.). ROG is nearly identical to U.S. EPA's Volatile Organic Compounds (VOC), which is based on EPA's exempt list. For all practical purposes, use of the term ROG and VOC are interchangeable. Also, various regulatory uses of the term VOC, such as that for consumer products exclude specific, additional compounds from particular control requirements.

The OG speciation profiles are applied to estimate the amounts of various organic compounds that make up TOG emissions. A speciation profile contains a list of organic compounds and the weight fraction that each compound comprises of the TOG emissions from a particular source type. In addition to the chemical name for each chemical constituent, the file also shows the chemical code (a 5-digit CARB internal identifier). The speciation profiles are applied to TOG to develop both the photochemical model inputs and the emission inventory for ROG. It should be noted that districts are allowed to report their own reactive fraction of TOG that is used to calculate ROG rather than use the information from the assigned organic gas speciation profiles. These district-reported fractions are not used in developing modeling inventories because the information needed to calculate the amount of each organic compound is not available.

The PM emissions are size fractionated by using PM size profiles, which contain the total weight fraction for $PM_{2.5}$ and PM_{10} out of total PM. The fine and coarse PM chemical compositions are characterized by applying the PM chemical speciation profiles for each source type, which contain the weight fractions of each chemical species for $PM_{2.5}$, PM_{10} and total PM. PM chemical speciation profiles may also vary for different PM size fractions even for the same emission source. PM size profiles and speciation profiles are typically generated based on source testing data. In most previous source testing studies aimed at determining PM chemical composition, filter-based sampling techniques were used to collect PM samples for chemical analyses.

The organic gas profiles and PM profiles used in the emission inventory are available for download from the CARB's web site at:
http://www.arb.ca.gov/ei/speciate/speciate.htm

Each process or product category is keyed to one of the OG profiles and one of the PM profiles. Also available for download from CARB’s web site is a cross-reference file that indicates which OG profile and PM profile are assigned to each category in the inventory. The inventory source categories are represented by an 8-digit source classification code (SCC) for point sources, or a 14-digit emission inventory code (EIC) for area and mobile sources. Some of the organic gas profiles and PM profiles related to motor vehicles, ocean going vessels, and fuel evaporative sources vary by the inventory year of interest, due to changes in fuel composition, vehicle fleet composition and diesel particulate filter (DPF) requirements over time. Details can be found in CARB’s documentation of heavy-duty diesel vehicle exhaust PM speciation profiles (ARB, 2011).

Research studies are conducted regularly to improve CARB’s speciation profiles. These profiles support ozone and PM modeling studies but are also designed to be used for aerosol and regional toxics modeling. The profiles are also used to support other health or welfare related modeling studies where the compounds of interest cannot always be anticipated. Therefore, speciation profiles need to be as complete and accurate as possible. CARB has an ongoing effort to update speciation profiles as data become available, such as through testing of emission sources or surveys of product formulations. New speciation data generally undergo technical and peer review, and updating of the profiles is coordinated with users of the data. The recent addition to CARB’s speciation profiles include:

(1) Organic gas profile

- Consumer products
- Architectural coating
- Gasoline fuel and headspace vapor
- Gasoline vehicle hot soak and diurnal evaporation
- Gasoline vehicle start and running exhaust
- Silage
- Aircraft exhaust
- Compressed Natural Gas (CNG) bus running exhaust

(2) PM profile

- Gasoline vehicle exhaust
- On-road diesel exhaust
- Off-road diesel exhaust
- Ocean going vessel exhaust
- Aircraft exhaust
- Concrete batching
- Commercial cooking
- Residential fuel combustion-natural gas
- Coating/painting
- Cotton ginning
- Stationary combustion

3. Methodology for Developing the Baseline Emission Inventory

As mentioned in Section 0, the baseline inventory includes temperature, humidity and solar insolation effects for some emission categories; development of these data is described in Sections 3.1 and 3.2. The remaining sections of Chapter 3 detail how the baseline inventory was created for different sectors of the inventory, such as for point, area, on-road motor vehicles, biogenic and other day-specific sources.

3.1. Surface Temperature and Relative Humidity Fields

The calculation of gridded emissions for some categories of the emissions inventory is dependent on meteorological variables. More specifically, biogenic emissions are sensitive to air temperatures and solar radiation while emissions from on-road mobile sources are sensitive to air temperature and relative humidity. As a result, estimates of air temperature (T), relative humidity (RH), and solar radiation are needed for each grid cell in the modeling domain in order to take into account the effects of these meteorological variables.

Gridded temperature and humidity fields are readily available from prognostic meteorological models such as the Weather Research and Forecasting (WRF) model (http://www.wrf-model.org/index.php), which is used to prepare meteorological inputs for the air quality model. However, prognostic meteorological models can at times have difficulty capturing diurnal temperature extremes (Valade, 2009; Caldwell, 2009; Fovell, 2008). Since temperature and the corresponding relative humidity extremes can have an appreciable influence on some emissions categories, such as on-road mobile and biogenic sources, measurement based fields for these parameters are used in processing emissions. The CALMET (http://www.src.com/) diagnostic meteorological model is utilized to generate both the gridded temperature and relative humidity fields used in processing emissions. The solar radiation fields needed for biogenic emission inventory calculations were taken from the WRF prognostic model, which is also used to generate meteorology for the air quality model. The principal steps involved in generating a gridded, surface-level temperature field using CALMET include the following:

1. Compute the relative weights of each surface observation station to each grid cell (the weight is inversely proportional to the distance between the surface observation station and grid cell center).
2. Adjust all surface temperatures to sea level. In this step, a lapse rate of -0.0049 ^{o}C/m is used (this lapse rate is based on private communication with Gary Moore of Earth Tech, Inc., Concord, MA). This lapse rate (=2.7 F/1000 feet) is based on observational data.
3. Use the weights to compute a spatially-averaged sea-level temperature for each grid cell.
4. Correct all sea-level temperatures back to 10 m height above ground level (i.e. the standard height of surface temperature measurements) using the lapse rate of -0.0049 ^{o}C/m again.
5. The current version of CALMET does not generate estimates of relative humidity. As a result, a post-processing program was used to produce gridded, hourly relative humidity estimates from observed relative humidity data. The major steps needed to generate gridded, surface-level relative humidity are described as follows:
    a. Calculate actual vapor pressure from observed relative humidity and temperature at all meteorological stations. The (Mc. Rae, 1980) method is used to calculate the saturated vapor pressure from temperature;

b. Compute the relative weights of each surface observation station to each grid in question, exactly as done by CALMET to compute the temperature field;
c. Use the weights from step 2 to compute a spatially-averaged estimate of actual vapor pressure in each grid cell;
d. For each grid cell, calculate relative humidity from values for actual vapor pressure and temperature for the same grid cell.

3.2. Insolation Effects

Insolation data was used in the estimation of the gridded emissions inventory and provided by the WRF meteorological fields as mentioned in Section 3.5.

3.3. Estimation of Gridded Area and Point sources

Emissions inventories that are temporally, chemically, and spatially resolved are needed as inputs for the photochemical air quality model. Point sources and area sources (area-wide, off-road mobile and aggregated stationary) are processed into emissions inventories for photochemical modeling using the SMOKE (Sparse Matrix Operator Kernel Emissions) modeling system (https://www.cmascenter.org/smoke/). Improvements to SMOKE were recently implemented under CARB contract for version 4.0 of SMOKE (Baek, 2015).

Inputs for SMOKE are annual emissions totals from CEPAM and information for allocating to temporal, chemical, and spatial resolutions. Temporal inputs for SMOKE are screened for missing or invalid temporal codes as discussed in Section 4.1. Temporal allocation of emissions using SMOKE involves the disaggregation of annual emissions totals into monthly, day of week, and hour of day emissions totals. The temporal codes from Table 3 and Table 4 are reformatted into an input-ready format as explained in the SMOKE user's manual. Chemical speciation profiles, as described in Section 0, and emissions source cross-reference files used as inputs for SMOKE are developed by CARB staff. SMOKE uses the files for the chemical speciation of NOx, SOx, TOG and PM to species needed by photochemical air quality models.

Emissions for area sources are allocated to grid cells as defined by the modeling grid domain defined in Section 1.4. Emissions are spatially disaggregated by the use of spatial surrogates as described in Section 2.3. These spatial surrogates are converted to a SMOKE-ready format as described in the SMOKE user's manual. Emissions for point sources are allocated to grid cells by SMOKE using the latitude and longitude coordinates reported for each stack.

3.4. Estimation of On-road Motor Vehicle Emissions

The EMFAC emissions model is used by CARB to assess emissions from on-road vehicles including cars, trucks, and buses in California, and to support air quality planning efforts to meet the Federal Highway Administration's transportation planning requirements. EMFAC is designed to produce county-level, average-day estimates. As a result, these estimates must be disaggregated spatially and temporally into gridded, hourly estimates for air quality modeling.

The general methodology used to disaggregate EMFAC emission estimates is a two-step approach. The first step uses the Direct Travel Impact Model (DTIM4) (Systems Applications Inc., 2001) to produce gridded, hourly emission estimates. The second step distributes EMFAC emissions according to the spatiotemporal output from DTIM. This methodology has been peer reviewed by the Institute of Transportation Studies at the University of California, Irvine, under CCOS contract 11-4CCOS.

The spatiotemporal allocation of emissions from DTIM does not vary dramatically with small changes in meteorological data (T/RH), resulting in a negligible monthly variation of the spatial surrogate. However, differences in DTIM's winter versus summer spatiotemporal allocation are slightly appreciable. Therefore, spatial surrogates are created for a winter and a summer day.

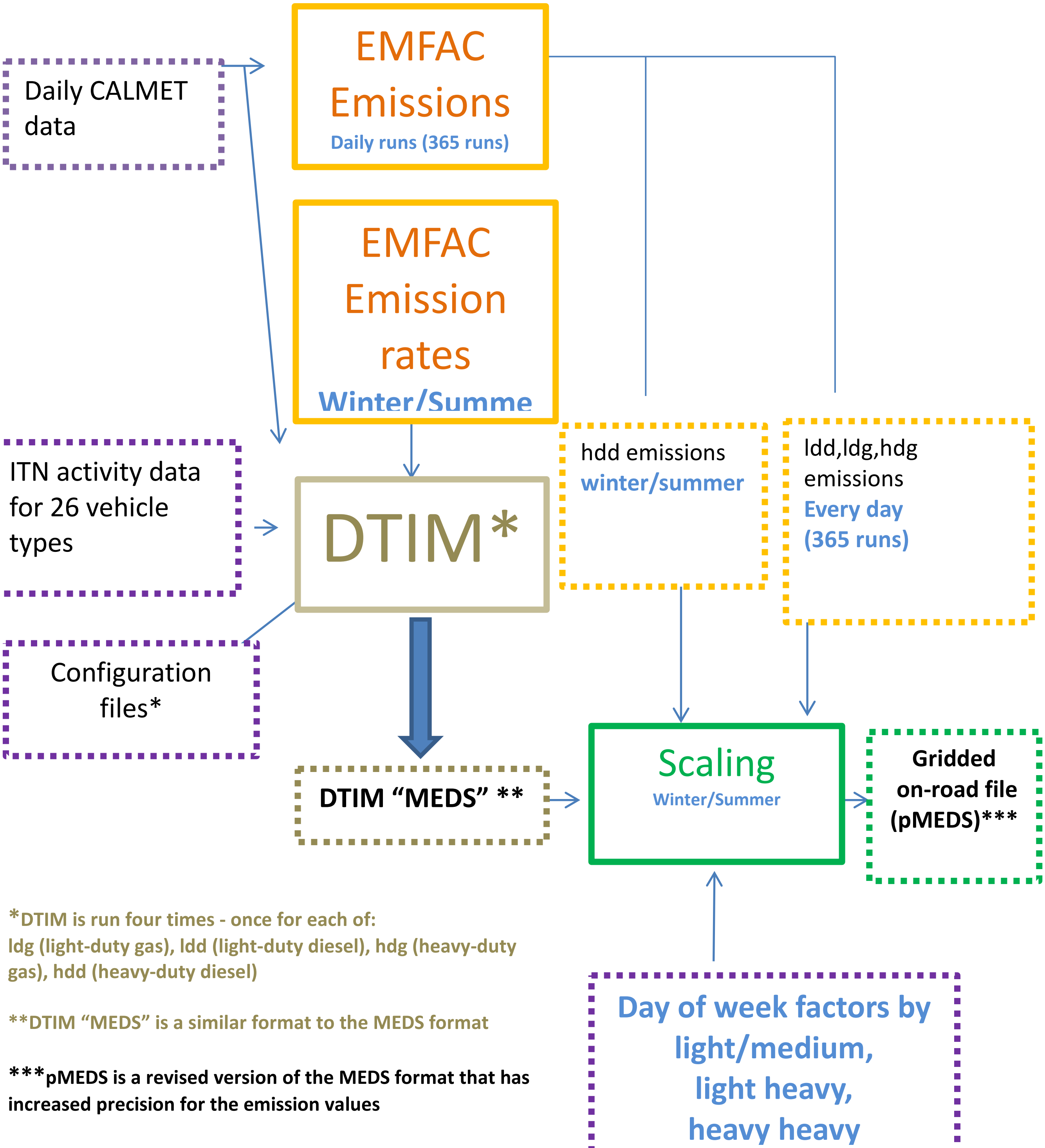
The most recent version of EMFAC, EMFAC2014, has three separate modules that are relevant for the preparation of the on-road emissions gridded inventory: one that estimates emissions, one that estimates emission rates, and one that estimates activity data. The emissions module is run for every county and every day of the modeled year using day-specific temperature and relative humidity. On a less granular level, the emissions rates module is run for every county for a summer day and a winter day. Lastly, the activity module is run once to estimates vehicle miles traveled (VMT), number of vehicle trips, fuel consumption, and the number of vehicles in use.

3.4.1. General Methodology: Mobile source emissions are sensitive to ambient temperature and humidity. Both EMFAC and DTIM account for meteorological effects using day-specific inputs. For EMFAC, hourly gridded temperature and humidity fields are averaged by county using a gridded VMT weighted average (i.e. weighted proportional to the VMT per grid cell in a county). DTIM accepts gridded, hourly data directly (CALMET formatted data). See Section 3.1 for more information.

EMFAC provides vehicle-class-specific emissions estimates for: exhaust, evaporative, tire wear, and brake wear emissions. EMFAC also produces estimates of: VMT, number of vehicle trips, fuel consumption, and the number of vehicles in use. More information on EMFAC can be found at (ARB-MSEI, 2015) . The vehicle activity is the most important input for spatiotemporal distribution of emissions. DTIM uses hourly vehicle miles traveled on each highway link and each of the vehicle trips in the modeling domain. The detailed vehicle activity data is obtained from CARB's Integrated Transportation Network (dtiv3) database.

The overall processing of on-road emissions to create the gridded emissions inventory can be seen in

Figure 3. Activity data from the ITN (see Section3.4.2) is developed for the thirteen EMFAC 2007 vehicle types, but activity is split for gas and diesel, resulting in a total of 26 vehicle types as shown in the block diagram.



*DTIM is run four times - once for each of:
ldg (light-duty gas), ldd (light-duty diesel), hdg (heavy-duty gas), hdd (heavy-duty diesel)

**DTIM "MEDS" is a similar format to the MEDS format

***pMEDS is a revised version of the MEDS format that has increased precision for the emission values

Figure 3 Block diagram for on-road processing

3.4.2. ITN Activity Data: The ITN is a database which is populated with link-based and Traffic Analysis Zone (TAZ)-based travel activity from travel demand models provided by different metropolitan planning organizations (MPOs), California Department of Transportation (Caltrans) and other California regional transportation planning agencies. The vintage and types of data used in the current version of the ITN are shown in Table 6. Different types of quality control parameters like vehicle mix, hourly distributions and post-mile coverage are obtained from default EMFAC and Caltrans databases. After these various pieces of data are imported to the database, the data can be examined for quality assurance. These input data sets are later moved into consolidated and geographically referenced master tables of link and TAZ activity data. Finally, these master tables are processed to produce hourly tables and hourly activity data input files for DTIM.

Table 6 Vintage of travel demand models for link based and traffic analysis zone

Metropolitan Planning Organizations	TDM Version Base year	Data types received	Data received on
AMBAG	2010	Links, Trips	06/15/2015
BCAG	2010	Links, Trips	05/13/2015
FCOG	2008	Links†	06/11/2015
CALTRANS	2010	Links, Trips	12/09/2014
KCOG	2010	Links†	06/11/2015
KCAG	2010	Links†	06/11/2015
MTC	2010	Links, Trips	03/23/2015
MCTC	2010	Links†	06/11/2015
MCAG	2010	Links, Trips	06/11/2015
SACOG	2010	Links, Trips	05/08/2014
SANDAG	2008	Links, Trips	12/09/2014
SBCAG	2010	Links, Trips	04/06/2015
SCAG	2008	Links, Trips	01/23/2014
SJCOG	2010	Links, Trips	06/11/2015
SLOCOG	2010	Links, Trips	12/19/2014
StanCOG	2010	Links, Trips	06/11/2015
SCRTPA	2010	Links, Trips	07/13/2015
TCAG	2010	Links†	06/11/2015
TMPO	2010	Links, Trips	04/02/2015

† Trips data from Caltrans Statewide Travel Demand model were used

3.4.3. Spatial Adjustment: The spatial allocation of county-wide EMFAC emissions is accomplished using gridded, hourly emission estimates from DTIM normalized by county. DTIM uses emission rates from EMFAC along with activity data, digitized roadway segments (links) and traffic analysis zone centroids to calculate gridded, hourly emissions for travel and trip ends. DTIM considers fewer vehicle categories than EMFAC outputs; therefore a mapping between EMFAC and DTIM vehicle categories is necessary. Categories of emissions after running DTIM are presented in Table 7. The categories are represented by the listed source classification codes (SCC) developed by CARB and depend on vehicle type, technology, and whether the vehicle is catalyst, non-catalyst, or diesel. Light- and medium-duty vehicles are separated from heavy-duty vehicles to allow for separate reporting and control strategy applications.

Table 7 DTIM Emission Categories

SCC for light and medium duty gas vehicles	SCC for heavy-duty gas vehicles	SCC for light-duty and medium-duty diesel vehicles	SCC for heavy-duty diesel vehicles	Description
202	302			Catalyst Start Exhaust
203	303			Catalyst Running Exhaust
204	304			Non-catalyst Start
205	305			Non-catalyst Running
206	306			Hot Soak
207	307			Diurnal Evaporatives
		808	408, 508	Diesel Exhaust
209	309			Running Evaporatives
210	310			Resting Evaporatives
211	311			Multi-Day Resting
212	312			Multi-Day Diurnal
213	313	813	413, 513, 613,	PM Tire Wear
214	314	814	414, 514, 614,	PM Brake Wear
215	315			Catalyst Buses
216	316			Non-catalyst Buses
		817	617, 717	Diesel Bus
218	318			Catalyst Idle
219	319			Non-catalyst Idle
		820	420, 520, 620,	Diesel Idle
221	321			PM Road Dust

DTIM and EMFAC2014 are both run using the 13 vehicle types shown in Table 8. In order to obtain better resolved spatiotemporal surrogates, the DTIM runs are split by light-duty (LDA, LDT1, LDT2, MDV, LHDT1, LHDT2, Urban Bus, MH, MCY) and heavy-duty (T6/T7 HHDT, SBUS, Other BUS) vehicle classes, and also by fuel type (gas, diesel). Each DTIM run outputs emissions for categories from 1-13; therefore, the mapping from Table 8 is used to preserve the spatial surrogates for each of the four DTIM runs. These codes depend on vehicle type, technology, and whether the vehicle is catalyst, non-catalyst, or diesel.

Table 8 Vehicle classification and type of adjustment

DTIM Category	Vehicle type	Type of adjustment
1	LDA	LD
2	LDT1	LD
3	LDT2	LD
4	MDV	LD
5	LHDT1	LM
6	LHDT2	LM
7	T6	LM
8	T7 HHDT	HHDT
9	Other Bus	LM
10	School Bus	Unadjusted on weekdays, zeroed on weekends
11	Urban Bus	LD
12	Motorhomes	LD
13	Motorcycles	LD

3.4.4. Temporal Adjustment (Day-of-Week adjustments to EMFAC daily totals): EMFAC2014 produces average day-of-week (DOW) estimates that represent Tuesday, Wednesday, and Thursday. In order to more accurately represent daily emissions, DOW adjustments are made to all emissions estimated on a Friday, Saturday, Sunday or Monday. The DOW adjustment factors were developed using CalVAD data. The California Vehicle Activity Database (CalVAD), developed by UC Irvine for CARB, is a system that fuses available data sources to produce a “best estimate” of vehicle activity by class. The CalVAD data set includes actual daily measurements of VMT on the road network for 43 of the 58 counties in California. However, there are seven counties that can't be used because the total vehicle miles traveled are less than the sum of the heavy heavy-duty truck vehicle miles traveled and trucks excluding heavy heavy-duty vehicle miles traveled. Furthermore, two more counties that have high vehicle miles traveled on Sunday are also excluded. Therefore, only 34 of these counties had useful data. In order to fill the missing 24 counties' data to cover all of California, a county which is nearby and similar in geography is selected for each of the missing counties. The CalVAD fractions were developed for three categories of vehicles: passenger cars (LD), light- and medium-duty trucks (LM), and heavy-heavy duty trucks (HHDT). Table 8 also shows the corresponding assignment to each vehicle type. Furthermore, the CalVAD fractions are scaled so that a typical workday (Tuesday, Wednesday, or Thursday) gets a scaling factor of 1.0. All other days of the week receive a scaling factor where their VMT is related back to the typical work day. This means there are a total of five weekday scaling factors. Lastly, the CalVAD data were used to create a typical holiday, because the traffic patterns for holidays are quite different than a typical week day. Thus, in the end, there are six daily fractions for each of the three vehicle classes, for all 58 counties. The DOW factors and vehicle type can be found in Appendix A: Day of week redistribution factors by vehicle type and county.

3.4.5. Temporal Adjustment (Hour-of-Day re-distribution of hourly travel network volumes): The travel networks provided by local transportation agencies and used with DTIM represent an hourly distribution for an average day. As for EMFAC, it is assumed that these average day-of-week hourly distributions represent hourly mid-week activities (i.e. for Tuesday, Wednesday, and Thursday). As such, they lack the temporal variations that are known to occur on other days of the week. To rectify this, the CalVAD data were used to develop hour-of-day profiles for Friday through Monday and a typical holiday. In a similar manner as the DOW factors, these hour-of-day profiles are used to re-allocate the hourly travel network distributions used in DTIM to Friday through Monday and a typical holiday. The hour-of-day profiles can be found in Appendix B: Hour of Day Profiles by vehicle type and county.

3.4.6. Summary of On-road Emissions Processing Steps: Eight general steps are used to spatially and temporally allocate EMFAC emissions by hour and grid cell:

1. Activity Data
    a. EMFAC is run in default mode for a single day to generate hourly activity data for each vehicle type and county: VMT, vehicle population, and number of vehicle trips. This is a single day's run, as EMFAC2014 yields the same hourly activity data for every day of the year.
    b. The activity data are used to generate various input files for ITN and DTIM. The general goal being to determine how much each activity belongs to each vehicle type through the day.

2. Road Network
    a. Pull a full copy of the California road network from the ITN database, using MPO inputs.
    b. Convert the ITN results to a form readable by DTIM.
    c. Apply travel network volumes by county hourly DOW fractions.

3. Meteorological Input Data
    a. Gridded, hourly temperature (T) and relative humidity (RH) are modeled using CALMET. Section 3.1 describes the development of these meteorological (met) data in more detail.
    b. Daily met files are prepared in formats readable by both EMFAC2014 and DTIM4.

4. EMFAC Emission Rates

   a. EMFAC is run in emissions rates mode (using monthly-average T and RH) to generate a look-up table of on-road mobile source emission rates by speed, temperature, and relative humidity for each county. These results are created on a monthly-average basis to save processing time.
   b. The emissions rates are pulled from the EMFAC database and reformatted in the DTIM-ready IRS file format.

5. EMFAC Emissions
   a. EMFAC is run in emissions mode (using day-specific T and RH) to provide county-wide on-road mobile source emission estimates by day and hour for EMFAC categories.
   b. These results are saved for later use.

6. DTIM
   a. DTIM is run for one week (five representative days since Tuesday, Wednesday and Thursday are treated as a single day) and one holiday in the summer and in the winter.
   b. Convert the DTIM output results into MEDS format for further processing.

More details on the DTIM and scaling processing can be found in the Appendix C.

7. Scale EMFAC Emissions Using DTIM
   a. For each day of EMFAC emissions, the closest day-of-week matching DTIM file is chosen for scaling.
   b. The daily, county-wide EMFAC emissions are distributed spatially and temporally using the DTIM MEDS files as surrogates, as shown by the equation:

$$E_{P,ij,hr,cat} = \frac{EF_{P,cat} \times DTIM_{P,ij,hr,cat}}{DTIM_{P,daily,cat,cnty}}$$

where:

E = grid cell emissions
EF = EMFAC emissions
DTIM = DTIM emissions
p = pollutant
i,j = grid cell
hr = hourly emissions
cat = emission category
daily = daily emissions
cnty = county

c. Finally, the Caltrans day-of-week factors are applied to the gridded, hourly emissions to better match traffic patterns.

8. Final Formatting

   a. The final step of on-road emissions processing is to convert the gridded, hourly emissions data to a NetCDF file usable by the CMAQ photochemical model.

3.5. Estimation of Gridded Biogenic Emissions

Biogenic emissions were estimated using the Model of Emissions of Gases and Aerosols from Nature (MEGAN) version 2.04 (Guenther, et al., 2006). MEGAN estimates biogenic emissions as a function of normalized emission rates (i.e. emission rates at standard conditions), which are adjusted to reflect variations in temperature, light, leaf area index (LAI), and leaf age (estimated from changes in LAI). The default MEGAN input databases for emission factors (EFs), plant functional types (PFTs), and LAI are not used in the application of MEGAN in California. Instead, California-specific emission factor and PFT databases were translated from those used in the Biogenic Emission Inventory GIS (BEIGIS) system (Scott & Benjamin, 2003) to improve emission estimates and to maintain consistency with previous California biogenic emission inventories. LAI data were derived from the MODIS 8-day LAI satellite product. Hourly surface temperatures were from observations gridded with the CALMET meteorological model and insolation data was provided by the WRF meteorological fields, as discussed in Section 3.1. Emissions of isoprene, monoterpenes, and methylbutenol were estimated from California-specific gridded emission factor data, while emissions of sesquiterpenes, methanol, and other volatile organic compounds were estimated from California-specific PFT data and PFT-derived emission rates.

MEGAN emissions estimates for California were evaluated during the California Airborne BVOC Emission Research in Natural Ecosystems Transects (CABERNET) field campaign in 2011 (Karl, et al., 2013), (Misztal, et al., 2014) and were shown to agree to within +/-20% of the measured fluxes (Misztal, et al., 2015), which is well within the stated model uncertainty of 50%.

3.6. Estimation of Other Day-Specific Sources

Day-specific data were used for preparing base case inventories when data were available. CARB and district staffs were able to gather hourly/daily emission information for 1) paved and unpaved road dust and 2) agricultural burns in six districts. Additionally, CARB and district staffs reflected residential wood curtailment programs in the baseline modeling inventory.

3.6.1. Paved Road Dust: Statewide emissions from paved road dust were adjusted for each day of the baseline year. The adjustment reduced emissions by 25% from paved road dust on days when precipitation occurred. Paved road dust emissions are calculated using the AP-42 method described in (U.S. EPA, 2011).

This methodology includes equations that adjust emissions based on average precipitation in a month; these precipitation-adjusted emissions were placed in the CEIDARS and CEPAM databases. Since daily precipitation totals are readily available, CARB and district staff agreed that paved road dust emissions should be estimated for each day rather than by month as described in the AP-42 methodology. The emissions from CEIDARS were replaced with day-specific data. A description of the steps used to calculate day-specific emissions is as follows:

Daily uncontrolled emissions for each county/air basin are estimated from the AP-42 methodology [Equation (1) on page 13.2.1-4]. No monthly precipitation adjustments are incorporated into the equation to estimate emissions.

To adjust for precipitation, daily precipitation data for 2012 were provided by an in-house database maintained by CARB staff that stores collected meteorology data from outside sources. The specific data sources for these data include: Remote Automated Weather Stations (RAWS), Atmospheric Infrared Sounder (AIRS), California Irrigation Management Information System (CIMIS) networks, SFBMET, and Federal Aviation Administration (FAA). FAA data provide precipitation data collected from airports in California.

If the precipitation is greater than or equal to 0.01 inches (measured anywhere in a county or county/air basin piece on a particular day), then the uncontrolled emissions are reduced by 25% for that day only. This reduction of emissions follows the recommendation in AP-42 as referenced above.

Replace the annual average emissions with day-specific emissions for every day in the corresponding emission inventory dataset.

3.6.2. Unpaved Road Dust: Statewide emissions from unpaved road dust were adjusted for rainfall suppression for each day of the year. The adjustment reduced county-wide emissions by 100% (total suppression) from unpaved road dust on days when precipitation greater than 0.01” occurred in a county/air basin. Dust emissions from unpaved roads were calculated using an emission factor derived from tests conducted by the University of California, Davis, and the Desert Research Institute (DRI). Unpaved road vehicle miles traveled (VMT) were based on county-specific road mileage estimates.

Emissions were assumed to be suppressed for each day with rainfall of 0.01 inch or greater using equation (2) from the method described in (U.S. EPA, 2011). The equation adjusts emissions based on annual precipitation; these precipitation-adjusted emissions were placed in the CEIDARS database. Similar to paved road dust, CARB and district staff agreed that unpaved road dust emissions should be estimated for each day. The emissions from CEIDARS were replaced with day-specific data for the appropriate years. Following is a description of the steps that were taken to calculate day-specific emissions.

a) Start with the daily uncontrolled emissions for each county/air basin as estimated from CARB's methodology. In other words, no precipitation adjustments have been incorporated in the emission estimates.
b) Use the same daily precipitation data as for paved road dust (see above)
c) If the precipitation is greater than or equal to 0.01 inches measured anywhere in a county or county/air basin portion on a particular day, then the emissions are removed for that day only.
d) Replace the annual average emissions with day-specific emissions for every day.

3.6.3. Agricultural Burning: Agricultural burning day-specific emission estimations were incorporated into the inventory for the following areas:

San Joaquin Valley

The San Joaquin Valley Air Pollution Control District estimated emissions for each day of 2012 when agricultural burning occurred. Emissions were estimated for the burning of prunings, field crops, weed abatement and other solid fuels. Information needed to estimate emissions came from the district's Smoke Management System, which stores information on burn permits issued by the district. In order to obtain a daily burn authorization, the person requesting the burn provides information to the district, including the acres and type of material to be burned, the specific location of the burn and the date of the burn. Acres are converted to tons of fuel burned using a fuel loading factor based on the specific crop to be burned. Emissions are calculated by multiplying the tons of fuel burned by a crop-specific emission factor. More information can be found in (ARB-Miscellaneous Methodologies, 2013).

To determine the location of the burn, district staff created spatial allocation factors for each 4 kilometer grid cell used in modeling. These factors were developed for “burn zones” in the San Joaquin Valley based on the agricultural land coverage. Daily emissions in each “agricultural burn zone” were then distributed across the zone/grid cell combinations using the spatial allocation factors. Emissions were summarized by grid cell and day.

Burning was assumed to occur over three hours from 10:00 a.m. to 1:00 p.m., except for two categories. Orchard removals were assumed to burn over eight hours from 10:00 a.m. to 6:00 p.m. Vineyard removals were assumed to burn over five hours from 10:00 a.m. to 3:00 p.m.

Ventura

Ventura County Air Pollution Control District provided emissions in Ventura County from agricultural burning for each day of 2012 when agricultural burning occurred. Using the same methodology as San Joaquin Valley, emissions were estimated for the burning of prunings, field crops, weed abatement, and range improvement. Information needed to estimate emissions came from burn permits issued by the district. In order to obtain a burn permit, the person requesting the burn provides information to the district, including the acres to be burned, the specific location of the burn and the date of the burn. Acres are converted to tons of fuel burned using a fuel loading factor based on the specific crop to be burned. Emissions are calculated by multiplying the tons of fuel burned by a crop-specific emission factor. The location of the burn was converted to latitude/longitude based on the address or description of location provided by the burn permit holder, then ultimately to grid cell. Burning was assumed to occur over three hours from 9:00 a.m. to 12:00 p.m.

Imperial

Imperial County Air Pollution Control District provided information needed to calculate emissions from agricultural and prescribed burning for each day of 2012 when agricultural burning occurred. Using the same methodology as San Joaquin Valley, emissions were estimated for the burning of field crops and weed abatement. The location of each burn was converted to latitude/longitude based on the nearest crossroads provided by the burn permit holder, then ultimately to grid cell. Burning was assumed to occur over four hours from 11:00 a.m. to 3:00 p.m.

3.6.4. Residential Wood Curtailment: Emissions were reduced to reflect residential wood curtailment days (no burn days) in two districts: San Joaquin Valley APCD and South Coast AQMD. Additionally, emissions were reduced in Calexico to reflect residential wood curtailment.

San Joaquin Valley

- **Base Year (2012):** SJVAPCD staff provided the dates in 2012 when a residential wood curtailment (RWC) was declared, based on the October 2008 district rule 4901. When a RWC was declared, emissions were reduced by 65% (i.e. 35% remaining) in the appropriate geographic regions (see Section 2.3.6).

South Coast

SCAQMD staff provided the dates in 2012 when a residential wood curtailment (RWC) was declared, based on district rule 455. When a RWC was declared, emissions were reduced by 75% (i.e. 25% remaining) in the appropriate geographic regions (see Section 2.3.6).

Calexico

Dates in 2012 when AQ observation data showed that PM2.5 concentrations were above 35 µg/m^3 in Calexico, emissions were reduced by 100% (i.e. zero emissions remaining).

4. Quality Assurance of Modeling Inventories

Quality assurance of the data that are used for modeling is fundamental in order to detect any possible outliers and potential problems with emission estimates. The most important quality assurance checks of the modeling emissions inventory are summarized in the following sections.

4.1. Area and Point Sources

Before utilizing SMOKE to process the annual emissions totals into temporally, chemically, and spatially-resolved emissions inventories for photochemical modeling, all SMOKE inputs are subject to extensive quality assurance procedures performed by CARB staff. Annual and forecasted emissions are carefully reviewed before input into SMOKE. CARB and district staff review data used to calculate emissions along with other associated data, such as the location of facilities and assignment of SCC to each process. Growth and control information are reviewed and updated as needed.

The next check is to compare annual average emissions from CEPAM with planning inventory totals to ensure data integrity. The planning and modeling inventories start with the same annual average emissions. The planning inventory is developed for an average summer day and an average winter day, whereas the modeling inventory is developed by month. Both inventory types use the same temporal data described in Section 2.2. The summer planning inventory uses the monthly throughputs from May through October. Similarly, the winter planning inventory uses the monthly throughputs from November through April. The modeling inventory produces emissions for a weekday, Saturday and Sunday for each month.

Annual emissions totals are plotted using the same gridding inputs as used in SMOKE in order to visually inspect and analyze the spatial allocation of emissions independent of temporal allocation and chemical speciation. Spatial plots by source category like the one shown in Figure 4 are carefully screened for proper spatial distribution of emissions.

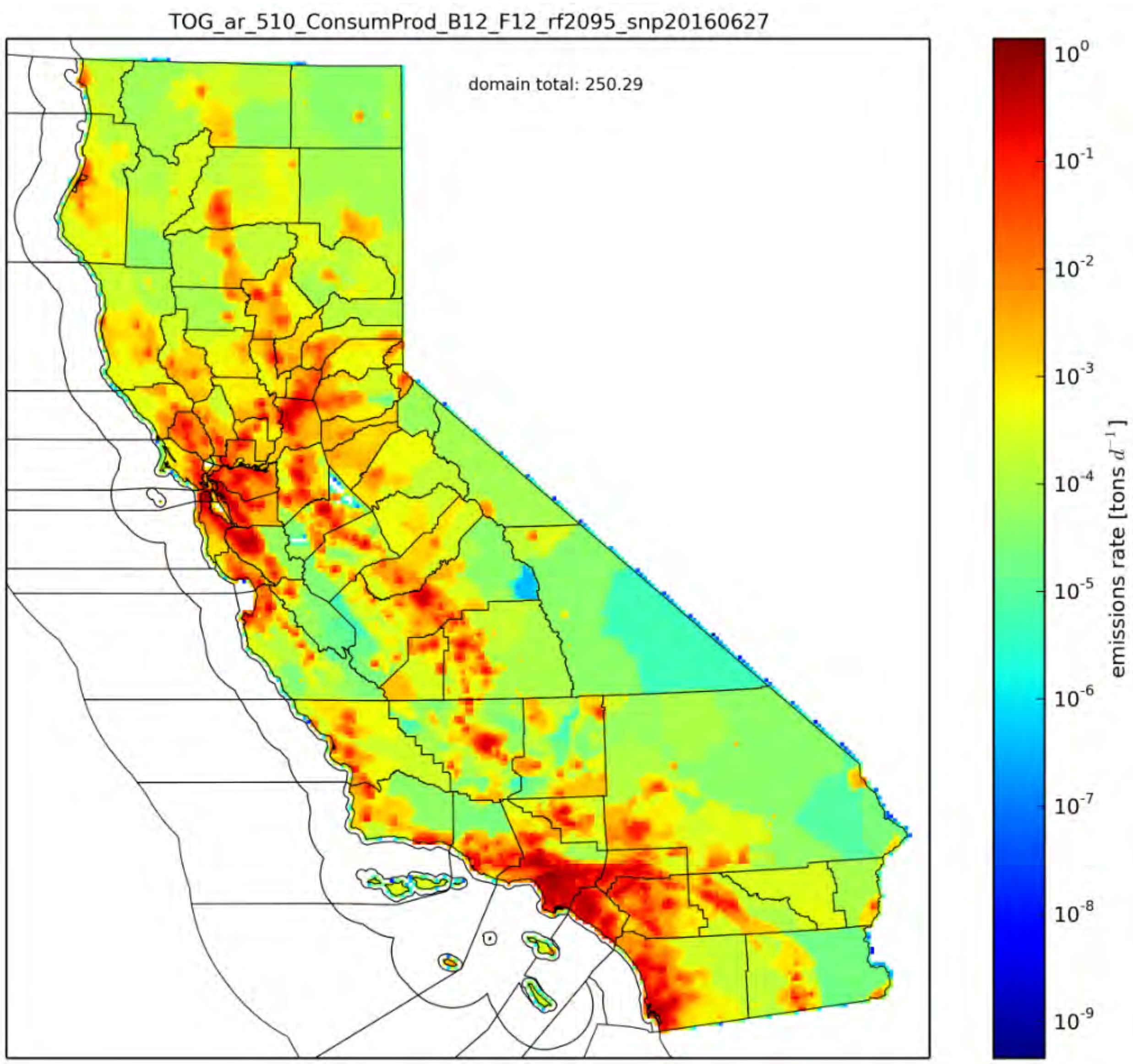


Figure 4 Example of a spatial plot by source category

Before air quality model-ready emissions files are generated by SMOKE, the run configurations and parameters set within the SMOKE environment are checked for consistency for both the reference and future years.

To aid in the quality assurance process, SMOKE is configured to generate inventory reports of temporally, chemically, and spatially-resolved emissions inventories. CARB staff utilize the SMOKE reports by checking emissions totals by source category and region, creating and analyzing time series plots, and comparing aggregate emissions totals with the pre-SMOKE emissions totals obtained from CEPAM. A screenshot capture of a portion of such report can be seen in Figure 5.

```
# Processed as Area sources
# Base inventory year      2012
# No gridding matrix applied
# No speciation matrix applied
# Temporal factors applied for episode from
#       Wednesday Aug. 8, 2012   at 080000 to
#       Thursday Aug. 9, 2012   at 080000
# Annual total data basis in report
#           ,             ,                     , [tons/day]    , [tons/day]    , [tons/day]    , [tons/day]    , [tons/day]    , [tons/day]
#Date       , Region      , SCC                 , CO            , NOX           , TOG           , NH3           , SOX           , PM
 08/09/2012, 0LC006017LAK, 00000005204212000010,    0.19098E-01,   0.46288E-01,   0.44956E-02,   0.00000E+00,   0.16055E-03,   0.16051E-02
 08/09/2012, 0LC006017LAK, 00000005204212000011,    0.94908E-02,   0.21052E-01,   0.30532E-02,   0.00000E+00,   0.00000E+00,   0.11252E-02
 08/09/2012, 0LC006017LAK, 00000011011003000000,    0.00000E+00,   0.00000E+00,   0.00000E+00,   0.63987E-03,   0.00000E+00,   0.00000E+00
 08/09/2012, 0LC006017LAK, 00000012012202420000,    0.00000E+00,   0.00000E+00,   0.00000E+00,   0.29915E-01,   0.00000E+00,   0.00000E+00
 08/09/2012, 0LC006017LAK, 00000019917002400000,    0.00000E+00,   0.00000E+00,   0.00000E+00,   0.13904E-01,   0.00000E+00,   0.00000E+00
 08/09/2012, 0LC006017LAK, 00000021020033000000,    0.00000E+00,   0.00000E+00,   0.13736E-01,   0.00000E+00,   0.00000E+00,   0.00000E+00
 08/09/2012, 0LC006017LAK, 00000021020081500000,    0.00000E+00,   0.00000E+00,   0.31439E-02,   0.00000E+00,   0.00000E+00,   0.00000E+00
 08/09/2012, 0LC006017LAK, 00000022020405000000,    0.00000E+00,   0.00000E+00,   0.31245E-01,   0.00000E+00,   0.00000E+00,   0.00000E+00
 08/09/2012, 0LC006017LAK, 00000022020430220000,    0.00000E+00,   0.00000E+00,   0.72951E-03,   0.00000E+00,   0.00000E+00,   0.00000E+00
 08/09/2012, 0LC006017LAK, 00000022020430830000,    0.00000E+00,   0.00000E+00,   0.36475E-03,   0.00000E+00,   0.00000E+00,   0.00000E+00
 08/09/2012, 0LC006017LAK, 00000022020432040000,    0.00000E+00,   0.00000E+00,   0.36475E-03,   0.00000E+00,   0.00000E+00,   0.00000E+00
```

Figure 5 Screen capture of a SMOKE-generated QA report

4.1.1. Area and Point Sources Temporal Profiles: Checks for missing or invalid temporal assignments are conducted to ensure accurate temporal allocation of emissions. Special attention is paid to checking monthly throughputs and appropriate monthly temporal distribution of emissions for each source category. In addition, checks for time-invariant temporal assignments are done for certain source categories and suitable alternate temporal assignments are determined and applied. For the agricultural source sector (e.g. agricultural pesticides/fertilizers, farming operations, fugitive windblown dust, managed burning and disposal, and farm equipment), replacement temporal assignments are extracted from the

Agricultural Emissions Temporal and Spatial Allocation Tool (AgTool). (Anderson, et al., 2012). The AgTool is a database management system capable of temporally and spatially allocating emissions from the agricultural source sector. It was developed by Sierra Research, Inc. and its subcontractor Alpine Geophysics, LLC along with collaboration from CARB and the San Joaquin Valley Air Pollution Control District (SJVAPCD). Temporal allocation data outputs from the AgTool, were compiled using input data provided by the UC Cooperative Extension, U.S. Department of Agriculture (USDA), and the CA Department of Pesticide Regulation (DPR).

Further improvements to temporal profiles used in the allocation of area source emissions are performed using suitable alternate temporal assignments determined by CARB staff. Select sources from manufacturing and industrial, degreasing, petroleum marketing, mineral processes, consumer products, residential fuel combustion, farming operations, aircraft, and commercial harbor craft sectors are among the source categories included in the application of adjustments to temporal allocation.

4.2. On-road Emissions

There are several processes to conduct quality assurance of the on-road mobile source modeling inventory at various stages of the inventory processing. The specific steps taken are described below:

1. Generate an ITN spatial plot to check if there were any missing network activities.
2. Generate a time series plot for each county to check the diurnal pattern of network activities.
3. Generate time series plots for the DTIM output files by county and by SCC to check the diurnal pattern.
4. Generate time series plots for the on-road mobile source files after scaling to EMFAC 2014 emissions (MEDS files) by county and SCC to check the diurnal pattern.

5. Compare the statewide daily total emissions for the MEDS files and the EMFAC 2014 emissions files to ensure that the emissions are the same.
6. Generate the spatial plot for the MEDS file to check if there were any missing emissions.
7. Generate time series and spatial plots again to check the final MEDS files.

4.3. Day-specific Sources

4.3.1. Paved Road Dust: The average daily emissions inventory was adjusted with day-specific precipitation data to produce a day-specific emissions inventory. Total emissions by county before the adjustment were compared to CEPAM for a reasonable match. After the adjustment, the day-specific total emissions by county were compared to CEPAM using time series plots. These plots were verified to confirm that there were only two values for every county/air basin/district: high values and low values. The high values are emissions that were not affected by rain adjustment, while the low values are emissions that were affected by the 25% rain adjustment reduction. Additionally the day-specific total was also compared to other inventory years to verify the expected growth trend.

4.3.2. Unpaved Road Dust: Unpaved road dust followed the same quality assurance process as paved road dust.

4.3.3. Agricultural Burning: Checks were done to verify the quality of the agricultural burn data. The day-specific emissions from agricultural burning were compared to the emissions from CEPAM for each county to check for reasonableness. Time series plots were reviewed for each county to see that days when burning occurred matched the days provided by the local air district. For each county, a few individual fires were calculated by hand starting from the raw data through all the steps to the final MEDS files to make sure the calculations were done correctly. Spatial plots were made to double check the locations of each burn.

4.4. Additional QA

In addition to the QA described above, comparisons are made between annual average inventories from CEPAM and modeling inventories. The modeling inventory shows emissions by month and subsequently calculates the annual average for comparison with CEPAM emissions. Annual average inventories and modeling inventories can be different, but differences should be well understood. For example, modeling inventories are adjusted to reflect different days of the week for on-road motor vehicles as detailed in Section 3.4; since weekend travel is generally less than weekday travel, modeling inventory emissions are usually lower when compared to annual average inventories from CEPAM. Figure 6 provides a screen capture of a report that summarizes different emission categories for San Luis Obispo County. Please note that this table is <u>only an example</u> since emissions have been updated from what is displayed here.

County:***40*** Spec:***NOx***

EIC	Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	CEPAM	Difference
10	electric utilities	0.12	0.11	0.1	0.06	0.09	0.13	0.13	0.16	0.14	0.16	0.14	0.13	0.12	0.12	0.00
20	cogeneration	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.00
30	oil and gas production (combustion)	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.00
40	petroleum refining (combustion)	0.3	0.3	0.26	0.3	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.26	0.31	0.31	0.00
50	manufacturing and industrial	0.06	0.06	0.06	0.06	0.07	0.06	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.00
52	food and agricultural processing	0.19	0.19	0.19	0.34	0.34	0.34	0.38	0.38	0.38	0.18	0.18	0.18	0.27	0.27	0.00
60	service and commercial	0.91	0.92	0.92	0.92	0.92	0.9	0.9	0.91	0.91	0.91	0.92	0.91	0.91	0.91	0.00
99	other (fuel combustion)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.00
110	sewage treatment	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
120	landfills	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
130	incinerators	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
140	soil remediation	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
199	other (waste disposal)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
210	laundering	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
220	degreasing	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
230	coatings and related process solvents	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
240	printing	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
250	adhesives and sealants	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
299	other (cleaning and surface coatings)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
310	oil and gas production	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
320	petroleum refining	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
330	petroleum marketing	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
399	other (petroleum production and marketing)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
410	chemical	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
420	food and agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
430	mineral processes	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.04	0.04	0.00
440	metal processes	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
450	wood and paper	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
460	glass and related products	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
470	electronics	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
499	other (industrial processes)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
510	consumer products	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
520	architectural coatings and related process sol	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
530	pesticides/fertilizers	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
540	asphalt paving / roofing	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
610	residential fuel combustion	0.73	0.73	0.68	0.65	0.57	0.57	0.57	0.57	0.57	0.65	0.7	0.73	0.64	0.64	0.00
620	farming operations	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
630	construction and demolition	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
640	paved road dust	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
645	unpaved road dust	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
650	fugitive windblown dust	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
660	fires	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
670	managed burning and disposal	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.00
690	cooking	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
699	other (miscellaneous processes)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
700	on-road vehicles	9.34	9.32	9.36	9.17	9.06	8.81	8.69	8.77	8.63	8.79	9.3	9.23	9.04	9.60	0.56
810	aircraft	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.00
820	trains	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.93	0.74
830	ships and commercial boats	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
833	ocean going vessels	11.23	11.23	11.23	11.23	11.23	11.23	11.23	11.23	11.23	11.23	11.23	11.23	11.23	11.52	0.29
835	commercial harbor craft	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	0.83	-0.29
840	recreational boats	0.05	0.05	0.17	0.18	0.16	0.47	0.46	0.43	0.12	0.11	0.11	0.06	0.2	0.20	0.00
850	off-road recreational vehicles	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.04	0.04	0.00
860	off-road equipment	1.08	1.24	1.21	1.24	1.25	1.28	1.25	1.25	1.28	1.21	1.19	1.12	1.21	1.21	0.00
870	farm equipment	1.08	1.22	1.72	1.77	2.21	2.21	2.16	2.21	2.17	1.52	1.14	1.06	1.71	1.71	0.00
890	fuel storage and handling	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
920	geogenic sources	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
***	Total	26.78	27.05	27.59	27.61	27.93	28.05	27.88	28.01	27.55	26.87	27.01	26.67	27.42	28.73	1.31

Notes:

CEPAM refers to annual average emissions from 2016 SIP Baseline Emission Inventory Tool with external adjustments: http://outapp.arb.ca.gov/cefs/2016o

Monthly gridded emissions comes from GeoVAST mo-yr/avg tabular summary - gid 319

On-road vehicles: The modeling inventory adjusts on-road by day of week as well as day-specific temperatures and relative humidity - Fridays are higher wit

time series plots shows weekdays are ~9-10 tpd

Trains: The modeling inventory reflects the revised locomotive emissions; the planning inventory reflects the previous emission estimates

OGV model produces gridded OGV emissions, which can vary from planning inventory (these emissions include OC1 and OC2 offshore air basins)

CHC The modeling inventory reflects the revised commercial harbor craft emissions; the planning inventory reflects the previous emission estimates

Figure 6 Screenshot of comparison of inventories report

Staff also review how modeling emissions vary over a year. Figure 7 provides an example of a modeling inventory time series plot for San Luis Obispo County for area-wide sources, on-road sources and off-road sources. Again, this figure is <u>only an example</u>.

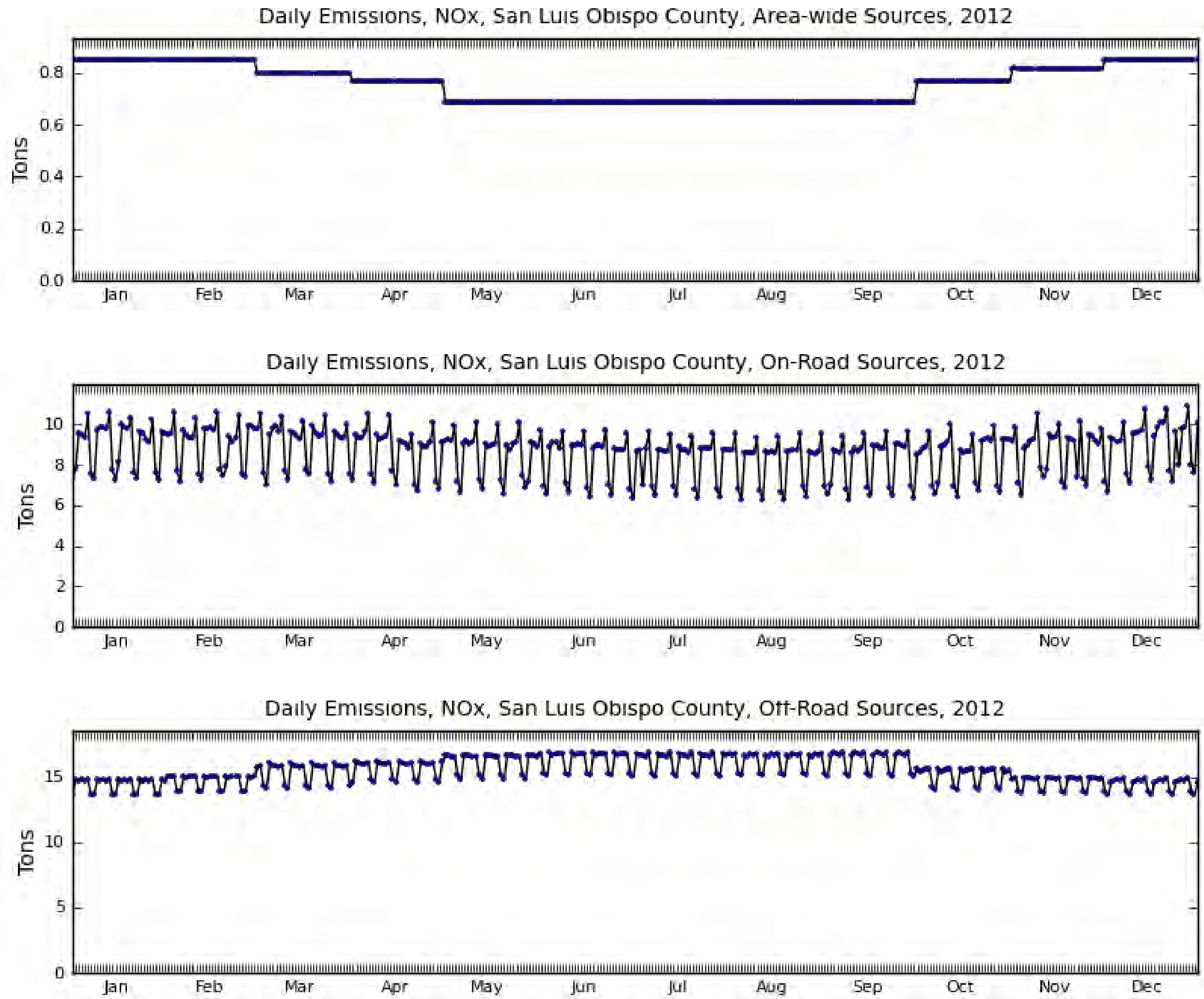


Figure 7 Daily variation of NOx emissions for mobile sources for San Luis Obispo

4.5. Model ready files QA

Prior to developing the modeling inventory emissions files used in the photochemical models, the same model-ready emissions files developed for the individual source categories (e.g. on-road, area, point, day-specific sources) are checked for quality assurance. Extensive quality assurance procedures are already performed by CARB staff on the intermediate emissions files (e.g. MEDS, SMOKE-generated reports), however, further checks are needed to ensure data integrity is preserved when the model-ready emissions files are generated from those intermediate emissions files.

Comparisons of the totals for both the intermediate and model-ready emissions files are made. Emissions totals are aggregated spatially, temporally, and chemically to single-layer, statewide, daily values by inventory pollutant. Spatial plots are also generated for both the intermediate and model-ready emissions files using the same graphical utilities and aggregated to the same spatial, temporal, and chemical resolution to allow equal comparison of emissions. Any discrepancies in the emissions totals are reconciled before proceeding with the development of the model-ready inventory emissions files.

Before combining the model-ready emissions files of the individual source category inventories into a single model-ready inventory, they are checked for completeness. Day-specific source inventories (when necessary) should have emissions for every day in the modeling period. Likewise, source inventories with emissions files that use averaged temporal allocation (e.g. day-of-week, weekday/weekend, monthly) should have model-ready emissions files to represent every day in the modeling period. In particular, it is important that during these checks source inventories with missing files are identified and resolved. Once all constituent source inventories are complete, they are used to develop the model-ready inventory used in photochemical modeling. When the modeling inventory files are generated, log files are also generated documenting what each daily model-ready emissions file is comprised of as an additional means of verifying that each daily model-ready inventory is complete.

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Appendix A: Day of week redistribution factors by vehicle type and county

The factors shown in Table 9 represent the “day of week” factors for each county for a broad vehicle class: LD is Light Duty, LM is Light and Medium Duty Trucks, and HH is Heavy- Heavy Duty Trucks.

Table 9 Day of week adjustment by vehicle class and county

County	Day of Week	LD	LM	HH
Alameda	Sunday	0.797	0.496	0.324
Alameda	Monday	0.948	0.919	0.893
Alameda	Tues/Wed/Thurs	1	1	1
Alameda	Friday	1.051	1.014	0.959
Alameda	Saturday	0.929	0.618	0.369
Alameda	Holiday	0.797	0.866	0.829
Alpine	Sunday	1.201	0.821	0.415
Alpine	Monday	1.007	0.945	0.908
Alpine	Tues/Wed/Thurs	1	1	1
Alpine	Friday	1.247	1.082	1.007
Alpine	Saturday	1.219	0.803	0.442
Alpine	Holiday	1.118	0.935	0.832
Amador	Sunday	1.201	0.821	0.415
Amador	Monday	1.007	0.945	0.908
Amador	Tues/Wed/Thurs	1	1	1
Amador	Friday	1.247	1.082	1.007
Amador	Saturday	1.219	0.803	0.442
Amador	Holiday	1.118	0.935	0.832
Butte	Sunday	0.651	0.442	0.41
Butte	Monday	0.964	0.96	0.871
Butte	Tues/Wed/Thurs	1	1	1
Butte	Friday	1.008	1.015	0.962
Butte	Saturday	0.771	0.604	0.503
Butte	Holiday	0.73	0.657	0.606
Calaveras	Sunday	1.201	0.821	0.415
Calaveras	Monday	1.007	0.945	0.908
Calaveras	Tues/Wed/Thurs	1	1	1
Calaveras	Friday	1.247	1.082	1.007
Calaveras	Saturday	1.219	0.803	0.442
Calaveras	Holiday	1.118	0.935	0.832
Colusa	Sunday	0.651	0.442	0.41
Colusa	Monday	0.964	0.96	0.871
Colusa	Tues/Wed/Thurs	1	1	1
Colusa	Friday	1.008	1.015	0.962
Colusa	Saturday	0.771	0.604	0.503
Colusa	Holiday	0.73	0.657	0.606
Contra Costa	Sunday	0.779	0.519	0.376
Contra Costa	Monday	0.943	0.927	0.873
Contra Costa	Tues/Wed/Thurs	1	1	1
Contra Costa	Friday	1.048	1.023	0.982
Contra Costa	Saturday	0.924	0.665	0.471
Contra Costa	Holiday	0.788	0.827	0.799
Del Norte	Sunday	0.85	0.493	0.326
Del Norte	Monday	0.961	0.95	0.915
Del Norte	Tues/Wed/Thurs	1	1	1
Del Norte	Friday	1.031	1.004	0.932
Del Norte	Saturday	0.924	0.619	0.376
Del Norte	Holiday	0.77	0.619	0.527
El Dorado	Sunday	0.972	0.668	0.602
El Dorado	Monday	0.988	0.977	0.943
El Dorado	Tues/Wed/Thurs	1	1	1
El Dorado	Friday	1.178	1.101	0.963
El Dorado	Saturday	1.037	0.786	0.575
El Dorado	Holiday	0.971	0.933	0.921
Fresno	Sunday	0.851	0.443	0.396
Fresno	Monday	1.016	0.934	0.878
Fresno	Tues/Wed/Thurs	1	1	1
Fresno	Friday	1.155	1.026	0.927
Fresno	Saturday	0.946	0.563	0.478
Fresno	Holiday	0.799	0.774	0.784
Glenn	Sunday	0.651	0.442	0.41

County	Day of Week	LD	LM	HH
Glenn	Monday	0.964	0.96	0.871
Glenn	Tues/Wed/Thurs	1	1	1
Glenn	Friday	1.008	1.015	0.962
Glenn	Saturday	0.771	0.604	0.503
Glenn	Holiday	0.73	0.657	0.606
Humboldt	Sunday	0.85	0.493	0.326
Humboldt	Monday	0.961	0.95	0.915
Humboldt	Tues/Wed/Thurs	1	1	1
Humboldt	Friday	1.031	1.004	0.932
Humboldt	Saturday	0.924	0.619	0.376
Humboldt	Holiday	0.77	0.619	0.527
Imperial	Sunday	1.082	0.608	0.396
Imperial	Monday	1.004	0.931	0.948
Imperial	Tues/Wed/Thurs	1	1	1
Imperial	Friday	1.109	1.161	0.983
Imperial	Saturday	1.065	0.687	0.522
Imperial	Holiday	1.024	0.814	0.673
Inyo	Sunday	1.201	0.821	0.415
Inyo	Monday	1.007	0.945	0.908
Inyo	Tues/Wed/Thurs	1	1	1
Inyo	Friday	1.247	1.082	1.007
Inyo	Saturday	1.219	0.803	0.442
Inyo	Holiday	1.118	0.935	0.832
Kern	Sunday	1.114	0.63	0.416
Kern	Monday	1.061	0.942	0.849
Kern	Tues/Wed/Thurs	1	1	1
Kern	Friday	1.253	1.044	0.9
Kern	Saturday	1.1	0.734	0.535
Kern	Holiday	0.986	0.911	0.837
Kings	Sunday	0.663	0.358	0.355
Kings	Monday	0.961	0.909	0.89
Kings	Tues/Wed/Thurs	1	1	1
Kings	Friday	1.045	0.982	0.947
Kings	Saturday	0.807	0.52	0.454
Kings	Holiday	0.669	0.665	0.758
Lake	Sunday	0.85	0.493	0.326
Lake	Monday	0.961	0.95	0.915
Lake	Tues/Wed/Thurs	1	1	1
Lake	Friday	1.031	1.004	0.932
Lake	Saturday	0.924	0.619	0.376
Lake	Holiday	0.77	0.619	0.527
Lassen	Sunday	0.941	0.703	0.587
Lassen	Monday	0.993	0.942	0.798
Lassen	Tues/Wed/Thurs	1	1	1
Lassen	Friday	1.094	1.07	0.882
Lassen	Saturday	0.962	0.766	0.658
Lassen	Holiday	0.968	0.744	0.608
Los Angeles	Sunday	0.858	0.489	0.398
Los Angeles	Monday	0.973	0.936	0.878
Los Angeles	Tues/Wed/Thurs	1	1	1
Los Angeles	Friday	1.047	1.005	0.918
Los Angeles	Saturday	0.979	0.641	0.509
Los Angeles	Holiday	0.863	0.808	0.801
Madera	Sunday	1.017	0.478	0.4
Madera	Monday	1.024	0.942	0.902
Madera	Tues/Wed/Thurs	1	1	1
Madera	Friday	1.176	1.022	0.96
Madera	Saturday	1.105	0.602	0.476
Madera	Holiday	0.866	0.833	0.832
Marin	Sunday	0.779	0.519	0.376
Marin	Monday	0.943	0.927	0.873
Marin	Tues/Wed/Thurs	1	1	1
Marin	Friday	1.048	1.023	0.982
Marin	Saturday	0.924	0.665	0.471
Marin	Holiday	0.788	0.827	0.799
Mariposa	Sunday	1.201	0.821	0.415
Mariposa	Monday	1.007	0.945	0.908
Mariposa	Tues/Wed/Thurs	1	1	1
Mariposa	Friday	1.247	1.082	1.007
Mariposa	Saturday	1.219	0.803	0.442
Mariposa	Holiday	1.118	0.935	0.832
Mendocino	Sunday	0.85	0.493	0.326
Mendocino	Monday	0.961	0.95	0.915
Mendocino	Tues/Wed/Thurs	1	1	1

County	Day of Week	LD	LM	HH
Mendocino	Friday	1.031	1.004	0.932
Mendocino	Saturday	0.924	0.619	0.376
Mendocino	Holiday	0.77	0.619	0.527
Merced	Sunday	1.002	0.593	0.421
Merced	Monday	1.009	0.958	0.904
Merced	Tues/Wed/Thurs	1	1	1
Merced	Friday	1.185	1.103	0.97
Merced	Saturday	1.055	0.713	0.477
Merced	Holiday	0.977	0.897	0.797
Modoc	Sunday	1.133	0.801	0.638
Modoc	Monday	1.159	0.961	0.634
Modoc	Tues/Wed/Thurs	1	1	1
Modoc	Friday	1.202	1.109	0.767
Modoc	Saturday	1.041	0.819	0.745
Modoc	Holiday	1.087	0.992	0.704
Mono	Sunday	1.201	0.821	0.415
Mono	Monday	1.007	0.945	0.908
Mono	Tues/Wed/Thurs	1	1	1
Mono	Friday	1.247	1.082	1.007
Mono	Saturday	1.219	0.803	0.442
Mono	Holiday	1.118	0.935	0.832
Monterey	Sunday	1.2	0.603	0.342
Monterey	Monday	1.106	0.988	0.876
Monterey	Tues/Wed/Thurs	1	1	1
Monterey	Friday	1.116	1.093	0.995
Monterey	Saturday	1.023	0.724	0.7
Monterey	Holiday	1.083	0.755	0.607
Napa	Sunday	1.028	0.624	0.392
Napa	Monday	0.989	0.95	0.895
Napa	Tues/Wed/Thurs	1	1	1
Napa	Friday	1.126	1.041	0.988
Napa	Saturday	1.118	0.743	0.44
Napa	Holiday	0.952	0.905	0.847
Nevada	Sunday	0.972	0.668	0.602
Nevada	Monday	0.988	0.977	0.943
Nevada	Tues/Wed/Thurs	1	1	1
Nevada	Friday	1.178	1.101	0.963
Nevada	Saturday	1.037	0.786	0.575
Nevada	Holiday	0.971	0.933	0.921
Orange	Sunday	0.808	0.415	0.327
Orange	Monday	0.962	0.92	0.891
Orange	Tues/Wed/Thurs	1	1	1
Orange	Friday	1.038	1.025	0.988
Orange	Saturday	0.94	0.587	0.433
Orange	Holiday	0.831	0.774	0.796
Placer	Sunday	0.972	0.668	0.602
Placer	Monday	0.988	0.977	0.943
Placer	Tues/Wed/Thurs	1	1	1
Placer	Friday	1.178	1.101	0.963
Placer	Saturday	1.037	0.786	0.575
Placer	Holiday	0.971	0.933	0.921
Plumas	Sunday	0.651	0.442	0.41
Plumas	Monday	0.964	0.96	0.871
Plumas	Tues/Wed/Thurs	1	1	1
Plumas	Friday	1.008	1.015	0.962
Plumas	Saturday	0.771	0.604	0.503
Plumas	Holiday	0.73	0.657	0.606
Riverside	Sunday	0.894	0.489	0.383
Riverside	Monday	0.974	0.941	0.887
Riverside	Tues/Wed/Thurs	1	1	1
Riverside	Friday	1.085	1.028	0.977
Riverside	Saturday	1.011	0.629	0.491
Riverside	Holiday	0.933	0.848	0.844
Sacramento	Sunday	0.774	0.49	0.431
Sacramento	Monday	0.963	0.954	0.913
Sacramento	Tues/Wed/Thurs	1	1	1
Sacramento	Friday	1.065	1.039	0.973
Sacramento	Saturday	0.884	0.622	0.502
Sacramento	Holiday	0.809	0.832	0.852
San Benito	Sunday	1.2	0.603	0.342
San Benito	Monday	1.106	0.988	0.876
San Benito	Tues/Wed/Thurs	1	1	1
San Benito	Friday	1.116	1.093	0.995
San Benito	Saturday	1.023	0.724	0.7

County	Day of Week	LD	LM	HH
San Benito	Holiday	1.083	0.755	0.607
San Bernardino	Sunday	0.89	0.56	0.532
San Bernardino	Monday	0.988	0.931	0.913
San Bernardino	Tues/Wed/Thurs	1	1	1
San Bernardino	Friday	1.094	1.069	1.012
San Bernardino	Saturday	0.97	0.743	0.634
San Bernardino	Holiday	0.942	0.818	0.831
San Diego	Sunday	0.796	0.532	0.341
San Diego	Monday	0.963	0.928	0.882
San Diego	Tues/Wed/Thurs	1	1	1
San Diego	Friday	1.067	1.022	0.982
San Diego	Saturday	0.928	0.665	0.446
San Diego	Holiday	0.808	0.785	0.785
San Francisco	Sunday	0.852	0.522	0.39
San Francisco	Monday	0.928	0.897	0.888
San Francisco	Tues/Wed/Thurs	1	1	1
San Francisco	Friday	1.05	1.002	0.98
San Francisco	Saturday	0.957	0.639	0.452
San Francisco	Holiday	0.783	0.811	0.84
San Joaquin	Sunday	0.933	0.5	0.393
San Joaquin	Monday	0.984	0.918	0.908
San Joaquin	Tues/Wed/Thurs	1	1	1
San Joaquin	Friday	1.128	1.086	0.976
San Joaquin	Saturday	1.035	0.657	0.466
San Joaquin	Holiday	0.907	0.77	0.757
San Luis Obispo	Sunday	1.038	0.629	0.413
San Luis Obispo	Monday	1.064	0.97	0.935
San Luis Obispo	Tues/Wed/Thurs	1	1	1
San Luis Obispo	Friday	1.113	1.094	1.047
San Luis Obispo	Saturday	0.99	0.725	0.563
San Luis Obispo	Holiday	0.967	0.714	0.669
San Mateo	Sunday	0.714	0.439	0.324
San Mateo	Monday	0.926	0.89	0.887
San Mateo	Tues/Wed/Thurs	1	1	1
San Mateo	Friday	1.02	0.983	0.978
San Mateo	Saturday	0.835	0.55	0.402
San Mateo	Holiday	0.78	0.742	0.767
Santa Barbara	Sunday	0.81	0.388	0.301
Santa Barbara	Monday	1.044	0.952	0.912
Santa Barbara	Tues/Wed/Thurs	1	1	1
Santa Barbara	Friday	1.08	1.011	0.996
Santa Barbara	Saturday	0.829	0.542	0.562
Santa Barbara	Holiday	0.811	0.535	0.545
Santa Clara	Sunday	0.734	0.489	0.343
Santa Clara	Monday	0.954	0.909	0.906
Santa Clara	Tues/Wed/Thurs	1	1	1
Santa Clara	Friday	1.042	1.004	0.953
Santa Clara	Saturday	0.853	0.614	0.4
Santa Clara	Holiday	0.765	0.834	0.807
Santa Cruz	Sunday	0.846	0.526	0.468
Santa Cruz	Monday	0.935	0.923	0.947
Santa Cruz	Tues/Wed/Thurs	1	1	1
Santa Cruz	Friday	1.027	1.012	1.036
Santa Cruz	Saturday	0.935	0.652	0.541
Santa Cruz	Holiday	0.9	0.896	0.875
Shasta	Sunday	1.076	0.823	0.627
Shasta	Monday	0.939	1.007	0.66
Shasta	Tues/Wed/Thurs	1	1	1
Shasta	Friday	1.078	1.156	0.774
Shasta	Saturday	1.117	0.863	0.719
Shasta	Holiday	0.902	0.837	0.602
Sierra	Sunday	0.972	0.668	0.602
Sierra	Monday	0.988	0.977	0.943
Sierra	Tues/Wed/Thurs	1	1	1
Sierra	Friday	1.178	1.101	0.963
Sierra	Saturday	1.037	0.786	0.575
Sierra	Holiday	0.971	0.933	0.921
Siskiyou	Sunday	1.133	0.801	0.638
Siskiyou	Monday	1.159	0.961	0.634
Siskiyou	Tues/Wed/Thurs	1	1	1
Siskiyou	Friday	1.202	1.109	0.767
Siskiyou	Saturday	1.041	0.819	0.745
Siskiyou	Holiday	1.087	0.992	0.704
Solano	Sunday	1.008	0.589	0.36

County	Day of Week	LD	LM	HH
Solano	Monday	0.979	0.948	0.887
Solano	Tues/Wed/Thurs	1	1	1
Solano	Friday	1.13	1.033	0.969
Solano	Saturday	1.091	0.719	0.416
Solano	Holiday	0.909	0.896	0.844
Sonoma	Sunday	0.779	0.519	0.376
Sonoma	Monday	0.943	0.927	0.873
Sonoma	Tues/Wed/Thurs	1	1	1
Sonoma	Friday	1.048	1.023	0.982
Sonoma	Saturday	0.924	0.665	0.471
Sonoma	Holiday	0.788	0.827	0.799
Stanislaus	Sunday	1.002	0.593	0.421
Stanislaus	Monday	1.009	0.958	0.904
Stanislaus	Tues/Wed/Thurs	1	1	1
Stanislaus	Friday	1.185	1.103	0.97
Stanislaus	Saturday	1.055	0.713	0.477
Stanislaus	Holiday	0.977	0.897	0.797
Sutter	Sunday	0.972	0.668	0.602
Sutter	Monday	0.988	0.977	0.943
Sutter	Tues/Wed/Thurs	1	1	1
Sutter	Friday	1.178	1.101	0.963
Sutter	Saturday	1.037	0.786	0.575
Sutter	Holiday	0.971	0.933	0.921
Tehama	Sunday	1.076	0.823	0.627
Tehama	Monday	0.939	1.007	0.66
Tehama	Tues/Wed/Thurs	1	1	1
Tehama	Friday	1.078	1.156	0.774
Tehama	Saturday	1.117	0.863	0.719
Tehama	Holiday	0.902	0.837	0.602
Trinity	Sunday	1.133	0.801	0.638
Trinity	Monday	1.159	0.961	0.634
Trinity	Tues/Wed/Thurs	1	1	1
Trinity	Friday	1.202	1.109	0.767
Trinity	Saturday	1.041	0.819	0.745
Trinity	Holiday	1.087	0.992	0.704
Tulare	Sunday	1.029	0.429	0.185
Tulare	Monday	1.052	0.936	0.912
Tulare	Tues/Wed/Thurs	1	1	1
Tulare	Friday	1.099	1.02	0.97
Tulare	Saturday	0.993	0.67	0.503
Tulare	Holiday	0.942	0.585	0.567
Tuolumne	Sunday	1.201	0.821	0.415
Tuolumne	Monday	1.007	0.945	0.908
Tuolumne	Tues/Wed/Thurs	1	1	1
Tuolumne	Friday	1.247	1.082	1.007
Tuolumne	Saturday	1.219	0.803	0.442
Tuolumne	Holiday	1.118	0.935	0.832
Ventura	Sunday	0.772	0.406	0.491
Ventura	Monday	0.956	0.924	0.932
Ventura	Tues/Wed/Thurs	1	1	1
Ventura	Friday	1.036	0.992	1.004
Ventura	Saturday	0.888	0.554	0.637
Ventura	Holiday	0.817	0.785	0.863
Yolo	Sunday	0.902	0.563	0.357
Yolo	Monday	0.972	0.954	0.932
Yolo	Tues/Wed/Thurs	1	1	1
Yolo	Friday	1.099	1.045	0.973
Yolo	Saturday	0.992	0.669	0.426
Yolo	Holiday	0.895	0.883	0.861
Yuba	Sunday	0.972	0.668	0.602
Yuba	Monday	0.988	0.977	0.943
Yuba	Tues/Wed/Thurs	1	1	1
Yuba	Friday	1.178	1.101	0.963
Yuba	Saturday	1.037	0.786	0.575
Yuba	Holiday	0.971	0.933	0.921

Appendix B: Hour of Day Profiles by vehicle type and county

The factors shown in Table 10 represent the “day of week” factors for each county for a broad vehicle class: LD is Light Duty, LM is Light and Medium Duty Trucks, and HH is Heavy- Heavy Duty Trucks.

Table 10 Hour of Day Profiles by vehicle type and county

		Alameda			Alpine			Amador			Butte			Calaveras			Colusa			Contra Costa		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Sunday	0	0.020	0.041	0.061	0.010	0.014	0.032	0.010	0.014	0.032	0.015	0.010	0.015	0.010	0.014	0.032	0.015	0.010	0.015	0.019	0.038	0.053
Sunday	1	0.013	0.039	0.056	0.007	0.011	0.024	0.007	0.011	0.024	0.010	0.006	0.011	0.007	0.011	0.024	0.010	0.006	0.011	0.012	0.034	0.047
Sunday	2	0.010	0.039	0.052	0.005	0.011	0.022	0.005	0.011	0.022	0.007	0.004	0.012	0.005	0.011	0.022	0.007	0.004	0.012	0.008	0.031	0.043
Sunday	3	0.007	0.038	0.049	0.004	0.010	0.021	0.004	0.010	0.021	0.006	0.004	0.012	0.004	0.010	0.021	0.006	0.004	0.012	0.006	0.030	0.040
Sunday	4	0.007	0.037	0.046	0.004	0.010	0.020	0.004	0.010	0.020	0.006	0.005	0.017	0.004	0.010	0.020	0.006	0.005	0.017	0.006	0.029	0.038
Sunday	5	0.010	0.038	0.044	0.007	0.013	0.021	0.007	0.013	0.021	0.010	0.011	0.029	0.007	0.013	0.021	0.010	0.011	0.029	0.010	0.031	0.038
Sunday	6	0.016	0.038	0.043	0.012	0.019	0.026	0.012	0.019	0.026	0.016	0.017	0.037	0.012	0.019	0.026	0.016	0.017	0.037	0.016	0.033	0.039
Sunday	7	0.022	0.039	0.042	0.019	0.023	0.029	0.019	0.023	0.029	0.023	0.029	0.051	0.019	0.023	0.029	0.023	0.029	0.051	0.023	0.036	0.040
Sunday	8	0.032	0.040	0.041	0.032	0.035	0.038	0.032	0.035	0.038	0.033	0.043	0.071	0.032	0.035	0.038	0.033	0.043	0.071	0.033	0.040	0.042
Sunday	9	0.046	0.043	0.041	0.051	0.051	0.053	0.051	0.051	0.053	0.047	0.063	0.091	0.051	0.051	0.053	0.047	0.063	0.091	0.048	0.046	0.044
Sunday	10	0.059	0.046	0.041	0.067	0.067	0.071	0.067	0.067	0.071	0.057	0.075	0.084	0.067	0.067	0.071	0.057	0.075	0.084	0.062	0.051	0.045
Sunday	11	0.065	0.047	0.039	0.080	0.081	0.085	0.080	0.081	0.085	0.067	0.083	0.079	0.080	0.081	0.085	0.067	0.083	0.079	0.067	0.053	0.046
Sunday	12	0.069	0.048	0.038	0.083	0.081	0.076	0.083	0.081	0.076	0.074	0.090	0.070	0.083	0.081	0.076	0.074	0.090	0.070	0.070	0.054	0.046
Sunday	13	0.071	0.049	0.036	0.085	0.082	0.074	0.085	0.082	0.074	0.078	0.089	0.061	0.085	0.082	0.074	0.078	0.089	0.061	0.073	0.055	0.050
Sunday	14	0.072	0.049	0.035	0.085	0.083	0.069	0.085	0.083	0.069	0.079	0.081	0.057	0.085	0.083	0.069	0.079	0.081	0.057	0.073	0.055	0.047
Sunday	15	0.071	0.049	0.034	0.084	0.081	0.066	0.084	0.081	0.066	0.080	0.079	0.053	0.084	0.081	0.066	0.080	0.079	0.053	0.073	0.053	0.041
Sunday	16	0.070	0.048	0.033	0.082	0.079	0.060	0.082	0.079	0.060	0.079	0.075	0.045	0.082	0.079	0.060	0.079	0.075	0.045	0.072	0.052	0.039
Sunday	17	0.069	0.048	0.034	0.076	0.070	0.053	0.076	0.070	0.053	0.075	0.066	0.043	0.076	0.070	0.053	0.075	0.066	0.043	0.070	0.050	0.038

		Alameda			Alpine			Amador			Butte			Calaveras			Colusa			Contra Costa		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Sunday	18	0.063	0.045	0.033	0.064	0.056	0.043	0.064	0.056	0.043	0.066	0.054	0.039	0.064	0.056	0.043	0.066	0.054	0.039	0.063	0.047	0.036
Sunday	19	0.057	0.043	0.035	0.049	0.043	0.035	0.049	0.043	0.035	0.055	0.042	0.037	0.049	0.043	0.035	0.055	0.042	0.037	0.056	0.044	0.035
Sunday	20	0.052	0.041	0.036	0.038	0.033	0.024	0.038	0.033	0.024	0.045	0.031	0.030	0.038	0.033	0.024	0.045	0.031	0.030	0.051	0.041	0.036
Sunday	21	0.045	0.037	0.039	0.026	0.022	0.020	0.026	0.022	0.020	0.035	0.022	0.024	0.026	0.022	0.020	0.035	0.022	0.024	0.042	0.038	0.037
Sunday	22	0.033	0.032	0.043	0.017	0.014	0.017	0.017	0.014	0.017	0.023	0.013	0.018	0.017	0.014	0.017	0.023	0.013	0.018	0.030	0.032	0.039
Sunday	23	0.021	0.027	0.049	0.010	0.010	0.020	0.010	0.010	0.020	0.014	0.008	0.015	0.010	0.010	0.020	0.014	0.008	0.015	0.019	0.027	0.043
Monday	0	0.009	0.026	0.032	0.006	0.010	0.017	0.006	0.010	0.017	0.006	0.002	0.006	0.006	0.010	0.017	0.006	0.002	0.006	0.007	0.023	0.029
Monday	1	0.004	0.027	0.032	0.004	0.009	0.016	0.004	0.009	0.016	0.004	0.002	0.007	0.004	0.009	0.016	0.004	0.002	0.007	0.003	0.022	0.028
Monday	2	0.003	0.028	0.033	0.003	0.009	0.016	0.003	0.009	0.016	0.003	0.002	0.010	0.003	0.009	0.016	0.003	0.002	0.010	0.002	0.022	0.029
Monday	3	0.005	0.030	0.035	0.005	0.011	0.019	0.005	0.011	0.019	0.003	0.004	0.012	0.005	0.011	0.019	0.003	0.004	0.012	0.003	0.023	0.030
Monday	4	0.014	0.033	0.039	0.008	0.017	0.024	0.008	0.017	0.024	0.007	0.009	0.021	0.008	0.017	0.024	0.007	0.009	0.021	0.012	0.028	0.035
Monday	5	0.034	0.039	0.044	0.019	0.028	0.036	0.019	0.028	0.036	0.018	0.024	0.037	0.019	0.028	0.036	0.018	0.024	0.037	0.033	0.041	0.042
Monday	6	0.051	0.046	0.048	0.036	0.041	0.050	0.036	0.041	0.050	0.041	0.051	0.055	0.036	0.041	0.050	0.041	0.051	0.055	0.054	0.051	0.048
Monday	7	0.064	0.053	0.052	0.051	0.044	0.065	0.051	0.044	0.065	0.078	0.069	0.066	0.051	0.044	0.065	0.078	0.069	0.066	0.066	0.058	0.053
Monday	8	0.064	0.055	0.053	0.053	0.056	0.068	0.053	0.056	0.068	0.067	0.077	0.077	0.053	0.056	0.068	0.067	0.077	0.077	0.062	0.060	0.055
Monday	9	0.058	0.054	0.054	0.059	0.065	0.080	0.059	0.065	0.080	0.057	0.071	0.080	0.059	0.065	0.080	0.057	0.071	0.080	0.055	0.056	0.054
Monday	10	0.053	0.053	0.054	0.067	0.074	0.087	0.067	0.074	0.087	0.057	0.071	0.077	0.067	0.074	0.087	0.057	0.071	0.077	0.052	0.054	0.053
Monday	11	0.051	0.054	0.054	0.071	0.075	0.082	0.071	0.075	0.082	0.060	0.074	0.073	0.071	0.075	0.082	0.060	0.074	0.073	0.053	0.055	0.054
Monday	12	0.052	0.056	0.054	0.074	0.074	0.080	0.074	0.074	0.080	0.063	0.072	0.071	0.074	0.074	0.080	0.063	0.072	0.071	0.054	0.056	0.054
Monday	13	0.054	0.057	0.054	0.074	0.075	0.075	0.074	0.075	0.075	0.063	0.072	0.068	0.074	0.075	0.075	0.063	0.072	0.068	0.056	0.056	0.054
Monday	14	0.061	0.059	0.053	0.077	0.076	0.065	0.077	0.076	0.065	0.067	0.077	0.064	0.077	0.076	0.065	0.067	0.077	0.064	0.063	0.059	0.056
Monday	15	0.066	0.059	0.051	0.082	0.076	0.058	0.082	0.076	0.058	0.078	0.080	0.056	0.082	0.076	0.058	0.078	0.080	0.056	0.069	0.063	0.058
Monday	16	0.069	0.057	0.048	0.081	0.073	0.045	0.081	0.073	0.045	0.086	0.077	0.049	0.081	0.073	0.045	0.086	0.077	0.049	0.072	0.060	0.052
Monday	17	0.070	0.053	0.044	0.071	0.059	0.035	0.071	0.059	0.035	0.087	0.062	0.041	0.071	0.059	0.035	0.087	0.062	0.041	0.073	0.056	0.047
Monday	18	0.062	0.045	0.037	0.052	0.042	0.023	0.052	0.042	0.023	0.051	0.038	0.030	0.052	0.042	0.023	0.051	0.038	0.030	0.061	0.045	0.039

		Alameda			Alpine			Amador			Butte			Calaveras			Colusa			Contra Costa		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Monday	19	0.048	0.035	0.031	0.037	0.030	0.017	0.037	0.030	0.017	0.036	0.024	0.024	0.037	0.030	0.017	0.036	0.024	0.024	0.045	0.033	0.031
Monday	20	0.036	0.028	0.026	0.027	0.022	0.013	0.027	0.022	0.013	0.026	0.018	0.023	0.027	0.022	0.013	0.026	0.018	0.023	0.035	0.026	0.026
Monday	21	0.031	0.022	0.023	0.020	0.016	0.010	0.020	0.016	0.010	0.020	0.012	0.021	0.020	0.016	0.010	0.020	0.012	0.021	0.031	0.022	0.024
Monday	22	0.024	0.018	0.023	0.015	0.012	0.009	0.015	0.012	0.009	0.013	0.007	0.017	0.015	0.012	0.009	0.013	0.007	0.017	0.023	0.017	0.023
Monday	23	0.016	0.015	0.025	0.009	0.007	0.010	0.009	0.007	0.010	0.008	0.004	0.015	0.009	0.007	0.010	0.008	0.004	0.015	0.014	0.014	0.025
Tues/Wed/Thurs	0	0.008	0.026	0.034	0.005	0.009	0.017	0.005	0.009	0.017	0.006	0.003	0.010	0.005	0.009	0.017	0.006	0.003	0.010	0.006	0.022	0.031
Tues/Wed/Thurs	1	0.004	0.027	0.034	0.003	0.008	0.017	0.003	0.008	0.017	0.003	0.002	0.011	0.003	0.008	0.017	0.003	0.002	0.011	0.003	0.021	0.030
Tues/Wed/Thurs	2	0.003	0.028	0.035	0.002	0.009	0.017	0.002	0.009	0.017	0.003	0.002	0.013	0.002	0.009	0.017	0.003	0.002	0.013	0.002	0.021	0.030
Tues/Wed/Thurs	3	0.005	0.030	0.037	0.003	0.010	0.022	0.003	0.010	0.022	0.003	0.003	0.015	0.003	0.010	0.022	0.003	0.003	0.015	0.003	0.023	0.031
Tues/Wed/Thurs	4	0.014	0.034	0.041	0.006	0.014	0.025	0.006	0.014	0.025	0.006	0.008	0.022	0.006	0.014	0.025	0.006	0.008	0.022	0.011	0.028	0.036
Tues/Wed/Thurs	5	0.035	0.040	0.046	0.018	0.027	0.039	0.018	0.027	0.039	0.017	0.024	0.037	0.018	0.027	0.039	0.017	0.024	0.037	0.034	0.040	0.044
Tues/Wed/Thurs	6	0.055	0.047	0.050	0.037	0.042	0.052	0.037	0.042	0.052	0.041	0.053	0.054	0.037	0.042	0.052	0.041	0.053	0.054	0.056	0.052	0.049
Tues/Wed/Thurs	7	0.067	0.054	0.053	0.053	0.047	0.064	0.053	0.047	0.064	0.077	0.069	0.066	0.053	0.047	0.064	0.077	0.069	0.066	0.068	0.059	0.054
Tues/Wed/Thurs	8	0.064	0.056	0.054	0.054	0.056	0.070	0.054	0.056	0.070	0.066	0.077	0.077	0.054	0.056	0.070	0.066	0.077	0.077	0.063	0.060	0.056
Tues/Wed/Thurs	9	0.057	0.054	0.055	0.059	0.068	0.083	0.059	0.068	0.083	0.057	0.071	0.080	0.059	0.068	0.083	0.057	0.071	0.080	0.055	0.055	0.053
Tues/Wed/Thurs	10	0.051	0.053	0.054	0.064	0.069	0.081	0.064	0.069	0.081	0.056	0.071	0.077	0.064	0.069	0.081	0.056	0.071	0.077	0.051	0.053	0.052
Tues/Wed/Thurs	11	0.049	0.054	0.054	0.068	0.069	0.077	0.068	0.069	0.077	0.058	0.071	0.074	0.068	0.069	0.077	0.058	0.071	0.074	0.050	0.054	0.052
Tues/Wed/Thurs	12	0.050	0.055	0.054	0.069	0.071	0.074	0.069	0.071	0.074	0.062	0.070	0.069	0.069	0.071	0.074	0.062	0.070	0.069	0.052	0.055	0.053
Tues/Wed/Thurs	13	0.053	0.056	0.053	0.072	0.073	0.074	0.072	0.073	0.074	0.063	0.073	0.067	0.072	0.073	0.074	0.063	0.073	0.067	0.054	0.056	0.054
Tues/Wed/Thurs	14	0.060	0.058	0.052	0.077	0.076	0.067	0.077	0.076	0.067	0.066	0.076	0.063	0.077	0.076	0.067	0.066	0.076	0.063	0.062	0.059	0.054
Tues/Wed/Thurs	15	0.064	0.058	0.050	0.084	0.078	0.058	0.084	0.078	0.058	0.079	0.080	0.056	0.084	0.078	0.058	0.079	0.080	0.056	0.067	0.063	0.056
Tues/Wed/Thurs	16	0.067	0.056	0.047	0.082	0.074	0.048	0.082	0.074	0.048	0.087	0.076	0.045	0.082	0.074	0.048	0.087	0.076	0.045	0.070	0.060	0.051
Tues/Wed/Thurs	17	0.067	0.052	0.042	0.074	0.061	0.036	0.074	0.061	0.036	0.088	0.062	0.040	0.074	0.061	0.036	0.088	0.062	0.040	0.071	0.057	0.046
Tues/Wed/Thurs	18	0.061	0.044	0.036	0.053	0.044	0.023	0.053	0.044	0.023	0.054	0.039	0.031	0.053	0.044	0.023	0.054	0.039	0.031	0.062	0.047	0.039
Tues/Wed/Thurs	19	0.050	0.035	0.030	0.038	0.031	0.016	0.038	0.031	0.016	0.036	0.026	0.023	0.038	0.031	0.016	0.036	0.026	0.023	0.048	0.035	0.031

		Alameda			Alpine			Amador			Butte			Calaveras			Colusa			Contra Costa		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Tues/Wed/Thurs	20	0.038	0.027	0.025	0.030	0.025	0.012	0.030	0.025	0.012	0.028	0.019	0.021	0.030	0.025	0.012	0.028	0.019	0.021	0.038	0.027	0.026
Tues/Wed/Thurs	21	0.033	0.022	0.022	0.023	0.018	0.010	0.023	0.018	0.010	0.021	0.013	0.020	0.023	0.018	0.010	0.021	0.013	0.020	0.033	0.022	0.024
Tues/Wed/Thurs	22	0.026	0.017	0.022	0.017	0.013	0.010	0.017	0.013	0.010	0.014	0.007	0.016	0.017	0.013	0.010	0.014	0.007	0.016	0.024	0.017	0.022
Tues/Wed/Thurs	23	0.016	0.014	0.023	0.010	0.008	0.010	0.010	0.008	0.010	0.009	0.004	0.013	0.010	0.008	0.010	0.009	0.004	0.013	0.015	0.013	0.024
Friday	0	0.009	0.027	0.036	0.005	0.009	0.019	0.005	0.009	0.019	0.007	0.003	0.011	0.005	0.009	0.019	0.007	0.003	0.011	0.008	0.022	0.033
Friday	1	0.005	0.028	0.037	0.003	0.008	0.019	0.003	0.008	0.019	0.004	0.003	0.012	0.003	0.008	0.019	0.004	0.003	0.012	0.004	0.021	0.031
Friday	2	0.004	0.029	0.038	0.002	0.008	0.019	0.002	0.008	0.019	0.004	0.003	0.015	0.002	0.008	0.019	0.004	0.003	0.015	0.003	0.022	0.032
Friday	3	0.005	0.031	0.039	0.002	0.008	0.021	0.002	0.008	0.021	0.004	0.004	0.017	0.002	0.008	0.021	0.004	0.004	0.017	0.004	0.023	0.033
Friday	4	0.013	0.034	0.043	0.005	0.013	0.024	0.005	0.013	0.024	0.006	0.007	0.024	0.005	0.013	0.024	0.006	0.007	0.024	0.010	0.028	0.036
Friday	5	0.032	0.040	0.048	0.013	0.023	0.037	0.013	0.023	0.037	0.015	0.022	0.039	0.013	0.023	0.037	0.015	0.022	0.039	0.030	0.039	0.044
Friday	6	0.049	0.046	0.052	0.026	0.035	0.049	0.026	0.035	0.049	0.035	0.045	0.055	0.026	0.035	0.049	0.035	0.045	0.055	0.050	0.049	0.050
Friday	7	0.060	0.052	0.055	0.039	0.040	0.060	0.039	0.040	0.060	0.063	0.063	0.064	0.039	0.040	0.060	0.063	0.063	0.064	0.063	0.057	0.055
Friday	8	0.059	0.054	0.056	0.043	0.049	0.068	0.043	0.049	0.068	0.058	0.072	0.074	0.043	0.049	0.068	0.058	0.072	0.074	0.059	0.057	0.056
Friday	9	0.054	0.053	0.056	0.049	0.057	0.073	0.049	0.057	0.073	0.052	0.068	0.075	0.049	0.057	0.073	0.052	0.068	0.075	0.053	0.054	0.054
Friday	10	0.051	0.053	0.056	0.058	0.063	0.078	0.058	0.063	0.078	0.055	0.071	0.074	0.058	0.063	0.078	0.055	0.071	0.074	0.051	0.053	0.053
Friday	11	0.052	0.055	0.055	0.064	0.069	0.077	0.064	0.069	0.077	0.060	0.074	0.074	0.064	0.069	0.077	0.060	0.074	0.074	0.053	0.055	0.054
Friday	12	0.054	0.056	0.055	0.066	0.071	0.076	0.066	0.071	0.076	0.063	0.072	0.069	0.066	0.071	0.076	0.063	0.072	0.069	0.056	0.057	0.055
Friday	13	0.056	0.057	0.054	0.071	0.074	0.077	0.071	0.074	0.077	0.065	0.076	0.069	0.071	0.074	0.077	0.065	0.076	0.069	0.058	0.058	0.056
Friday	14	0.061	0.058	0.052	0.076	0.077	0.070	0.076	0.077	0.070	0.069	0.078	0.063	0.076	0.077	0.070	0.069	0.078	0.063	0.064	0.059	0.056
Friday	15	0.063	0.058	0.049	0.083	0.079	0.060	0.083	0.079	0.060	0.078	0.080	0.055	0.083	0.079	0.060	0.078	0.080	0.055	0.066	0.062	0.056
Friday	16	0.064	0.055	0.045	0.083	0.077	0.050	0.083	0.077	0.050	0.085	0.075	0.047	0.083	0.077	0.050	0.085	0.075	0.047	0.067	0.059	0.050
Friday	17	0.064	0.051	0.040	0.075	0.064	0.038	0.075	0.064	0.038	0.082	0.061	0.039	0.075	0.064	0.038	0.082	0.061	0.039	0.067	0.055	0.046
Friday	18	0.059	0.044	0.034	0.062	0.051	0.025	0.062	0.051	0.025	0.059	0.041	0.029	0.062	0.051	0.025	0.059	0.041	0.029	0.060	0.047	0.039
Friday	19	0.052	0.035	0.027	0.050	0.039	0.018	0.050	0.039	0.018	0.042	0.028	0.024	0.050	0.039	0.018	0.042	0.028	0.024	0.049	0.036	0.030
Friday	20	0.042	0.028	0.022	0.041	0.030	0.013	0.041	0.030	0.013	0.032	0.021	0.021	0.041	0.030	0.013	0.032	0.021	0.021	0.040	0.029	0.023

		Alameda			Alpine			Amador			Butte			Calaveras			Colusa			Contra Costa		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Friday	21	0.036	0.023	0.019	0.036	0.025	0.010	0.036	0.025	0.010	0.027	0.015	0.020	0.036	0.025	0.010	0.027	0.015	0.020	0.035	0.023	0.020
Friday	22	0.032	0.019	0.017	0.030	0.019	0.011	0.030	0.019	0.011	0.021	0.011	0.016	0.030	0.019	0.011	0.021	0.011	0.016	0.030	0.019	0.019
Friday	23	0.023	0.015	0.018	0.018	0.012	0.009	0.018	0.012	0.009	0.014	0.007	0.015	0.018	0.012	0.009	0.014	0.007	0.015	0.022	0.015	0.020
Saturday	0	0.016	0.033	0.052	0.010	0.015	0.027	0.010	0.015	0.027	0.012	0.007	0.021	0.010	0.015	0.027	0.012	0.007	0.021	0.015	0.030	0.044
Saturday	1	0.010	0.033	0.051	0.007	0.012	0.023	0.007	0.012	0.023	0.008	0.005	0.016	0.007	0.012	0.023	0.008	0.005	0.016	0.009	0.027	0.040
Saturday	2	0.008	0.033	0.049	0.005	0.011	0.022	0.005	0.011	0.022	0.006	0.004	0.020	0.005	0.011	0.022	0.006	0.004	0.020	0.006	0.026	0.039
Saturday	3	0.006	0.034	0.048	0.004	0.010	0.025	0.004	0.010	0.025	0.005	0.004	0.022	0.004	0.010	0.025	0.005	0.004	0.022	0.005	0.025	0.037
Saturday	4	0.008	0.035	0.048	0.005	0.013	0.028	0.005	0.013	0.028	0.006	0.008	0.024	0.005	0.013	0.028	0.006	0.008	0.024	0.006	0.027	0.037
Saturday	5	0.014	0.037	0.049	0.010	0.021	0.034	0.010	0.021	0.034	0.012	0.017	0.039	0.010	0.021	0.034	0.012	0.017	0.039	0.013	0.030	0.040
Saturday	6	0.023	0.039	0.050	0.017	0.028	0.039	0.017	0.028	0.039	0.021	0.028	0.049	0.017	0.028	0.039	0.021	0.028	0.049	0.023	0.035	0.042
Saturday	7	0.033	0.041	0.051	0.029	0.036	0.053	0.029	0.036	0.053	0.034	0.041	0.058	0.029	0.036	0.053	0.034	0.041	0.058	0.034	0.041	0.047
Saturday	8	0.045	0.044	0.052	0.044	0.045	0.060	0.044	0.045	0.060	0.045	0.057	0.067	0.044	0.045	0.060	0.045	0.057	0.067	0.046	0.047	0.049
Saturday	9	0.054	0.047	0.052	0.059	0.061	0.071	0.059	0.061	0.071	0.054	0.068	0.074	0.059	0.061	0.071	0.054	0.068	0.074	0.055	0.051	0.050
Saturday	10	0.060	0.050	0.051	0.073	0.074	0.078	0.073	0.074	0.078	0.063	0.080	0.073	0.073	0.074	0.078	0.063	0.080	0.073	0.061	0.054	0.051
Saturday	11	0.064	0.052	0.050	0.081	0.077	0.083	0.081	0.077	0.083	0.068	0.082	0.071	0.081	0.077	0.083	0.068	0.082	0.071	0.065	0.056	0.052
Saturday	12	0.066	0.053	0.048	0.078	0.077	0.075	0.078	0.077	0.075	0.074	0.083	0.068	0.078	0.077	0.075	0.074	0.083	0.068	0.066	0.058	0.055
Saturday	13	0.066	0.053	0.045	0.075	0.072	0.060	0.075	0.072	0.060	0.074	0.079	0.062	0.075	0.072	0.060	0.074	0.079	0.062	0.067	0.059	0.058
Saturday	14	0.066	0.053	0.042	0.075	0.068	0.055	0.075	0.068	0.055	0.074	0.076	0.057	0.075	0.068	0.055	0.074	0.076	0.057	0.067	0.058	0.057
Saturday	15	0.066	0.053	0.040	0.075	0.068	0.052	0.075	0.068	0.052	0.073	0.074	0.052	0.075	0.068	0.052	0.073	0.074	0.052	0.068	0.057	0.051
Saturday	16	0.065	0.051	0.037	0.072	0.070	0.047	0.072	0.070	0.047	0.073	0.067	0.045	0.072	0.070	0.047	0.073	0.067	0.045	0.068	0.056	0.047
Saturday	17	0.065	0.050	0.034	0.066	0.063	0.040	0.066	0.063	0.040	0.069	0.058	0.039	0.066	0.063	0.040	0.069	0.058	0.039	0.067	0.054	0.044
Saturday	18	0.060	0.046	0.031	0.058	0.052	0.031	0.058	0.052	0.031	0.058	0.047	0.034	0.058	0.052	0.031	0.058	0.047	0.034	0.060	0.048	0.036
Saturday	19	0.050	0.041	0.028	0.047	0.041	0.026	0.047	0.041	0.026	0.046	0.036	0.029	0.047	0.041	0.026	0.046	0.036	0.029	0.049	0.041	0.029
Saturday	20	0.043	0.036	0.025	0.038	0.031	0.020	0.038	0.031	0.020	0.040	0.028	0.024	0.038	0.031	0.020	0.040	0.028	0.024	0.043	0.036	0.025
Saturday	21	0.042	0.033	0.024	0.031	0.025	0.016	0.031	0.025	0.016	0.036	0.022	0.023	0.031	0.025	0.016	0.036	0.022	0.023	0.041	0.033	0.024

		Alameda			Alpine			Amador			Butte			Calaveras			Colusa			Contra Costa		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Saturday	22	0.039	0.029	0.023	0.025	0.020	0.018	0.025	0.020	0.018	0.029	0.016	0.017	0.025	0.020	0.018	0.029	0.016	0.017	0.037	0.029	0.023
Saturday	23	0.029	0.025	0.023	0.016	0.013	0.018	0.016	0.013	0.018	0.020	0.011	0.017	0.016	0.013	0.018	0.020	0.011	0.017	0.028	0.024	0.022
Holiday	0	0.015	0.028	0.035	0.008	0.011	0.020	0.008	0.011	0.020	0.010	0.004	0.012	0.008	0.011	0.020	0.010	0.004	0.012	0.013	0.027	0.034
Holiday	1	0.008	0.029	0.035	0.005	0.009	0.018	0.005	0.009	0.018	0.006	0.004	0.011	0.005	0.009	0.018	0.006	0.004	0.011	0.007	0.026	0.033
Holiday	2	0.006	0.031	0.036	0.003	0.010	0.018	0.003	0.010	0.018	0.004	0.003	0.012	0.003	0.010	0.018	0.004	0.003	0.012	0.004	0.025	0.033
Holiday	3	0.005	0.032	0.037	0.004	0.010	0.021	0.004	0.010	0.021	0.004	0.005	0.015	0.004	0.010	0.021	0.004	0.005	0.015	0.003	0.025	0.033
Holiday	4	0.009	0.035	0.040	0.005	0.012	0.020	0.005	0.012	0.020	0.007	0.009	0.024	0.005	0.012	0.020	0.007	0.009	0.024	0.007	0.029	0.035
Holiday	5	0.019	0.037	0.043	0.009	0.018	0.031	0.009	0.018	0.031	0.014	0.020	0.037	0.009	0.018	0.031	0.014	0.020	0.037	0.017	0.034	0.039
Holiday	6	0.029	0.042	0.045	0.018	0.023	0.038	0.018	0.023	0.038	0.030	0.036	0.047	0.018	0.023	0.038	0.030	0.036	0.047	0.029	0.040	0.044
Holiday	7	0.038	0.046	0.048	0.029	0.031	0.043	0.029	0.031	0.043	0.044	0.052	0.061	0.029	0.031	0.043	0.044	0.052	0.061	0.038	0.045	0.047
Holiday	8	0.046	0.049	0.051	0.041	0.044	0.056	0.041	0.044	0.056	0.052	0.066	0.075	0.041	0.044	0.056	0.052	0.066	0.075	0.045	0.050	0.051
Holiday	9	0.049	0.050	0.052	0.058	0.057	0.075	0.058	0.057	0.075	0.053	0.071	0.081	0.058	0.057	0.075	0.053	0.071	0.081	0.049	0.053	0.052
Holiday	10	0.055	0.053	0.053	0.076	0.083	0.087	0.076	0.083	0.087	0.059	0.076	0.081	0.076	0.083	0.087	0.059	0.076	0.081	0.056	0.056	0.053
Holiday	11	0.060	0.056	0.054	0.084	0.086	0.088	0.084	0.086	0.088	0.066	0.076	0.071	0.084	0.086	0.088	0.066	0.076	0.071	0.062	0.059	0.055
Holiday	12	0.064	0.058	0.055	0.085	0.087	0.089	0.085	0.087	0.089	0.071	0.078	0.074	0.085	0.087	0.089	0.071	0.078	0.074	0.067	0.061	0.056
Holiday	13	0.066	0.059	0.054	0.083	0.081	0.078	0.083	0.081	0.078	0.071	0.076	0.065	0.083	0.081	0.078	0.071	0.076	0.065	0.070	0.062	0.056
Holiday	14	0.069	0.060	0.053	0.080	0.074	0.068	0.080	0.074	0.068	0.070	0.078	0.060	0.080	0.074	0.068	0.070	0.078	0.060	0.073	0.062	0.057
Holiday	15	0.069	0.058	0.051	0.078	0.074	0.060	0.078	0.074	0.060	0.075	0.075	0.053	0.078	0.074	0.060	0.075	0.075	0.053	0.071	0.061	0.054
Holiday	16	0.068	0.056	0.047	0.078	0.072	0.049	0.078	0.072	0.049	0.079	0.070	0.044	0.078	0.072	0.049	0.079	0.070	0.044	0.070	0.057	0.050
Holiday	17	0.066	0.051	0.043	0.071	0.066	0.041	0.071	0.066	0.041	0.074	0.064	0.041	0.071	0.066	0.041	0.074	0.064	0.041	0.067	0.053	0.044
Holiday	18	0.060	0.044	0.037	0.057	0.049	0.033	0.057	0.049	0.033	0.058	0.044	0.034	0.057	0.049	0.033	0.058	0.044	0.034	0.059	0.045	0.038
Holiday	19	0.052	0.036	0.031	0.043	0.040	0.022	0.043	0.040	0.022	0.047	0.033	0.026	0.043	0.040	0.022	0.047	0.033	0.026	0.051	0.036	0.031
Holiday	20	0.046	0.030	0.027	0.033	0.026	0.013	0.033	0.026	0.013	0.038	0.025	0.025	0.033	0.026	0.013	0.038	0.025	0.025	0.046	0.031	0.028
Holiday	21	0.042	0.025	0.024	0.024	0.018	0.011	0.024	0.018	0.011	0.030	0.018	0.021	0.024	0.018	0.011	0.030	0.018	0.021	0.041	0.026	0.026
Holiday	22	0.035	0.020	0.024	0.017	0.012	0.009	0.017	0.012	0.009	0.024	0.011	0.017	0.017	0.012	0.009	0.024	0.011	0.017	0.033	0.021	0.025

		Alameda			Alpine			Amador			Butte			Calaveras			Colusa			Contra Costa		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Holiday	23	0.024	0.016	0.026	0.010	0.008	0.010	0.010	0.008	0.010	0.014	0.007	0.014	0.010	0.008	0.010	0.014	0.007	0.014	0.021	0.017	0.026

		Del Norte			El Dorado			Fresno			Glenn			Humboldt			Imperial			Inyo		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Sunday	0	0.013	0.011	0.008	0.013	0.020	0.031	0.015	0.033	0.043	0.015	0.010	0.015	0.013	0.011	0.008	0.026	0.015	0.017	0.010	0.014	0.032
Sunday	1	0.013	0.008	0.010	0.008	0.016	0.028	0.010	0.030	0.040	0.010	0.006	0.011	0.013	0.008	0.010	0.026	0.013	0.016	0.007	0.011	0.024
Sunday	2	0.012	0.006	0.008	0.006	0.013	0.026	0.008	0.027	0.037	0.007	0.004	0.012	0.012	0.006	0.008	0.025	0.009	0.014	0.005	0.011	0.022
Sunday	3	0.014	0.005	0.007	0.005	0.012	0.025	0.005	0.025	0.034	0.006	0.004	0.012	0.014	0.005	0.007	0.025	0.008	0.015	0.004	0.010	0.021
Sunday	4	0.014	0.004	0.011	0.005	0.012	0.025	0.006	0.024	0.034	0.006	0.005	0.017	0.014	0.004	0.011	0.027	0.010	0.015	0.004	0.010	0.020
Sunday	5	0.017	0.009	0.019	0.008	0.015	0.027	0.010	0.026	0.034	0.010	0.011	0.029	0.017	0.009	0.019	0.030	0.015	0.017	0.007	0.013	0.021
Sunday	6	0.021	0.014	0.028	0.013	0.020	0.030	0.017	0.029	0.036	0.016	0.017	0.037	0.021	0.014	0.028	0.032	0.019	0.021	0.012	0.019	0.026
Sunday	7	0.026	0.020	0.036	0.022	0.028	0.034	0.022	0.032	0.037	0.023	0.029	0.051	0.026	0.020	0.036	0.033	0.026	0.029	0.019	0.023	0.029
Sunday	8	0.031	0.032	0.043	0.034	0.041	0.040	0.032	0.038	0.040	0.033	0.043	0.071	0.031	0.032	0.043	0.037	0.039	0.035	0.032	0.035	0.038
Sunday	9	0.040	0.050	0.054	0.048	0.055	0.046	0.044	0.046	0.044	0.047	0.063	0.091	0.040	0.050	0.054	0.040	0.053	0.047	0.051	0.051	0.053
Sunday	10	0.047	0.064	0.067	0.064	0.068	0.052	0.055	0.052	0.046	0.057	0.075	0.084	0.047	0.064	0.067	0.043	0.063	0.057	0.067	0.067	0.071
Sunday	11	0.055	0.079	0.062	0.075	0.075	0.055	0.063	0.057	0.047	0.067	0.083	0.079	0.055	0.079	0.062	0.046	0.071	0.065	0.080	0.081	0.085
Sunday	12	0.061	0.087	0.065	0.082	0.079	0.058	0.071	0.062	0.049	0.074	0.090	0.070	0.061	0.087	0.065	0.048	0.075	0.068	0.083	0.081	0.076
Sunday	13	0.065	0.092	0.064	0.084	0.079	0.058	0.076	0.064	0.049	0.078	0.089	0.061	0.065	0.092	0.064	0.052	0.078	0.068	0.085	0.082	0.074
Sunday	14	0.067	0.087	0.065	0.084	0.077	0.057	0.077	0.063	0.048	0.079	0.081	0.057	0.067	0.087	0.065	0.053	0.074	0.065	0.085	0.083	0.069
Sunday	15	0.072	0.086	0.067	0.082	0.073	0.057	0.077	0.061	0.047	0.080	0.079	0.053	0.072	0.086	0.067	0.056	0.071	0.061	0.084	0.081	0.066
Sunday	16	0.077	0.086	0.072	0.079	0.068	0.055	0.075	0.059	0.046	0.079	0.075	0.045	0.077	0.086	0.072	0.056	0.068	0.058	0.082	0.079	0.060
Sunday	17	0.070	0.075	0.058	0.072	0.062	0.053	0.073	0.056	0.045	0.075	0.066	0.043	0.070	0.075	0.058	0.059	0.067	0.055	0.076	0.070	0.053
Sunday	18	0.067	0.059	0.054	0.060	0.052	0.049	0.066	0.050	0.044	0.066	0.054	0.039	0.067	0.059	0.054	0.059	0.062	0.055	0.064	0.056	0.043
Sunday	19	0.062	0.045	0.050	0.050	0.043	0.045	0.057	0.044	0.042	0.055	0.042	0.037	0.062	0.045	0.050	0.057	0.051	0.051	0.049	0.043	0.035
Sunday	20	0.054	0.035	0.047	0.041	0.035	0.042	0.050	0.038	0.041	0.045	0.031	0.030	0.054	0.035	0.047	0.052	0.041	0.049	0.038	0.033	0.024
Sunday	21	0.045	0.024	0.039	0.031	0.026	0.039	0.040	0.033	0.040	0.035	0.022	0.024	0.045	0.024	0.039	0.047	0.032	0.044	0.026	0.022	0.020
Sunday	22	0.033	0.015	0.033	0.021	0.019	0.036	0.030	0.028	0.040	0.023	0.013	0.018	0.033	0.015	0.033	0.039	0.023	0.042	0.017	0.014	0.017
Sunday	23	0.022	0.009	0.032	0.013	0.015	0.033	0.020	0.023	0.039	0.014	0.008	0.015	0.022	0.009	0.032	0.031	0.018	0.038	0.010	0.010	0.020
Monday	0	0.010	0.003	0.007	0.008	0.014	0.027	0.009	0.019	0.024	0.006	0.002	0.006	0.010	0.003	0.007	0.025	0.010	0.016	0.006	0.010	0.017
Monday	1	0.009	0.002	0.007	0.005	0.012	0.025	0.005	0.018	0.023	0.004	0.002	0.007	0.009	0.002	0.007	0.025	0.008	0.016	0.004	0.009	0.016
Monday	2	0.010	0.003	0.010	0.004	0.012	0.025	0.004	0.018	0.023	0.003	0.002	0.010	0.010	0.003	0.010	0.024	0.008	0.017	0.003	0.009	0.016
Monday	3	0.012	0.006	0.012	0.006	0.014	0.027	0.005	0.020	0.025	0.003	0.004	0.012	0.012	0.006	0.012	0.030	0.014	0.019	0.005	0.011	0.019
Monday	4	0.014	0.009	0.013	0.011	0.019	0.030	0.011	0.023	0.027	0.007	0.009	0.021	0.014	0.009	0.013	0.030	0.022	0.025	0.008	0.017	0.024
Monday	5	0.022	0.022	0.026	0.023	0.030	0.036	0.024	0.034	0.033	0.018	0.024	0.037	0.022	0.022	0.026	0.034	0.036	0.031	0.019	0.028	0.036
Monday	6	0.037	0.047	0.044	0.042	0.047	0.043	0.044	0.047	0.041	0.041	0.051	0.055	0.037	0.047	0.044	0.036	0.043	0.034	0.036	0.041	0.050
Monday	7	0.045	0.058	0.058	0.060	0.061	0.048	0.069	0.064	0.048	0.078	0.069	0.066	0.045	0.058	0.058	0.040	0.056	0.039	0.051	0.044	0.065
Monday	8	0.047	0.062	0.067	0.059	0.062	0.050	0.063	0.062	0.049	0.067	0.077	0.077	0.047	0.062	0.067	0.041	0.065	0.045	0.053	0.056	0.068
Monday	9	0.050	0.065	0.078	0.056	0.061	0.050	0.055	0.056	0.047	0.057	0.071	0.080	0.050	0.065	0.078	0.043	0.064	0.051	0.059	0.065	0.080
Monday	10	0.051	0.065	0.080	0.058	0.064	0.051	0.055	0.056	0.048	0.057	0.071	0.077	0.051	0.065	0.080	0.044	0.069	0.058	0.067	0.074	0.087
Monday	11	0.056	0.067	0.083	0.062	0.066	0.053	0.057	0.059	0.050	0.060	0.074	0.073	0.056	0.067	0.083	0.047	0.071	0.066	0.071	0.075	0.082
Monday	12	0.058	0.069	0.081	0.066	0.068	0.054	0.061	0.061	0.052	0.063	0.072	0.071	0.058	0.069	0.081	0.048	0.068	0.067	0.074	0.074	0.080
Monday	13	0.063	0.074	0.076	0.067	0.067	0.054	0.063	0.062	0.054	0.063	0.072	0.068	0.063	0.074	0.076	0.050	0.070	0.067	0.074	0.075	0.075
Monday	14	0.067	0.076	0.074	0.070	0.069	0.055	0.069	0.065	0.056	0.067	0.077	0.064	0.067	0.076	0.074	0.051	0.069	0.066	0.077	0.076	0.065
Monday	15	0.073	0.087	0.062	0.073	0.069	0.055	0.074	0.068	0.058	0.078	0.080	0.056	0.073	0.087	0.062	0.057	0.072	0.062	0.082	0.076	0.058
Monday	16	0.076	0.084	0.053	0.075	0.067	0.054	0.079	0.068	0.059	0.086	0.077	0.049	0.076	0.084	0.053	0.054	0.063	0.061	0.081	0.073	0.045
Monday	17	0.075	0.075	0.040	0.073	0.061	0.052	0.076	0.062	0.057	0.087	0.062	0.041	0.075	0.075	0.040	0.057	0.054	0.055	0.071	0.059	0.035

		Del Norte			El Dorado			Fresno			Glenn			Humboldt			Imperial			Inyo		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Monday	18	0.057	0.047	0.032	0.056	0.046	0.045	0.053	0.043	0.050	0.051	0.038	0.030	0.057	0.047	0.032	0.054	0.040	0.047	0.052	0.042	0.023
Monday	19	0.050	0.031	0.029	0.040	0.031	0.039	0.037	0.030	0.043	0.036	0.024	0.024	0.050	0.031	0.029	0.052	0.032	0.041	0.037	0.030	0.017
Monday	20	0.043	0.020	0.021	0.031	0.022	0.035	0.030	0.023	0.039	0.026	0.018	0.023	0.043	0.020	0.021	0.047	0.022	0.037	0.027	0.022	0.013
Monday	21	0.035	0.015	0.020	0.025	0.017	0.032	0.024	0.018	0.035	0.020	0.012	0.021	0.035	0.015	0.020	0.045	0.018	0.031	0.020	0.016	0.010
Monday	22	0.025	0.009	0.014	0.017	0.012	0.030	0.018	0.013	0.032	0.013	0.007	0.017	0.025	0.009	0.014	0.038	0.013	0.026	0.015	0.012	0.009
Monday	23	0.016	0.005	0.013	0.012	0.009	0.030	0.012	0.010	0.029	0.008	0.004	0.015	0.016	0.005	0.013	0.030	0.014	0.025	0.009	0.007	0.010
Tues/Wed/Thurs	0	0.010	0.004	0.008	0.008	0.014	0.029	0.007	0.018	0.027	0.006	0.003	0.010	0.010	0.004	0.008	0.024	0.011	0.023	0.005	0.009	0.017
Tues/Wed/Thurs	1	0.009	0.003	0.008	0.004	0.011	0.027	0.004	0.017	0.027	0.003	0.002	0.011	0.009	0.003	0.008	0.025	0.009	0.020	0.003	0.008	0.017
Tues/Wed/Thurs	2	0.010	0.002	0.012	0.004	0.011	0.027	0.003	0.017	0.027	0.003	0.002	0.013	0.010	0.002	0.012	0.026	0.008	0.020	0.002	0.009	0.017
Tues/Wed/Thurs	3	0.011	0.005	0.014	0.005	0.013	0.029	0.004	0.019	0.028	0.003	0.003	0.015	0.011	0.005	0.014	0.027	0.012	0.022	0.003	0.010	0.022
Tues/Wed/Thurs	4	0.015	0.010	0.021	0.010	0.018	0.031	0.009	0.023	0.031	0.006	0.008	0.022	0.015	0.010	0.021	0.029	0.018	0.025	0.006	0.014	0.025
Tues/Wed/Thurs	5	0.024	0.024	0.035	0.022	0.029	0.037	0.024	0.032	0.036	0.017	0.024	0.037	0.024	0.024	0.035	0.034	0.036	0.032	0.018	0.027	0.039
Tues/Wed/Thurs	6	0.037	0.048	0.048	0.042	0.047	0.044	0.044	0.047	0.044	0.041	0.053	0.054	0.037	0.048	0.048	0.036	0.046	0.039	0.037	0.042	0.052
Tues/Wed/Thurs	7	0.045	0.059	0.065	0.060	0.061	0.050	0.070	0.064	0.051	0.077	0.069	0.066	0.045	0.059	0.065	0.040	0.057	0.044	0.053	0.047	0.064
Tues/Wed/Thurs	8	0.047	0.063	0.069	0.060	0.062	0.051	0.065	0.063	0.051	0.066	0.077	0.077	0.047	0.063	0.069	0.041	0.065	0.048	0.054	0.056	0.070
Tues/Wed/Thurs	9	0.050	0.064	0.074	0.055	0.060	0.050	0.055	0.057	0.049	0.057	0.071	0.080	0.050	0.064	0.074	0.041	0.062	0.053	0.059	0.068	0.083
Tues/Wed/Thurs	10	0.051	0.065	0.075	0.056	0.061	0.051	0.054	0.056	0.050	0.056	0.071	0.077	0.051	0.065	0.075	0.044	0.066	0.057	0.064	0.069	0.081
Tues/Wed/Thurs	11	0.055	0.065	0.076	0.059	0.064	0.052	0.055	0.058	0.051	0.058	0.071	0.074	0.055	0.065	0.076	0.046	0.067	0.061	0.068	0.069	0.077
Tues/Wed/Thurs	12	0.057	0.068	0.076	0.061	0.065	0.053	0.058	0.060	0.051	0.062	0.070	0.069	0.057	0.068	0.076	0.048	0.067	0.064	0.069	0.071	0.074
Tues/Wed/Thurs	13	0.061	0.070	0.071	0.064	0.066	0.053	0.061	0.062	0.053	0.063	0.073	0.067	0.061	0.070	0.071	0.049	0.069	0.063	0.072	0.073	0.074
Tues/Wed/Thurs	14	0.066	0.074	0.068	0.068	0.068	0.053	0.068	0.065	0.054	0.066	0.076	0.063	0.066	0.074	0.068	0.052	0.069	0.061	0.077	0.076	0.067
Tues/Wed/Thurs	15	0.073	0.084	0.062	0.073	0.069	0.053	0.074	0.067	0.056	0.079	0.080	0.056	0.073	0.084	0.062	0.055	0.071	0.057	0.084	0.078	0.058
Tues/Wed/Thurs	16	0.078	0.086	0.053	0.075	0.067	0.052	0.080	0.067	0.056	0.087	0.076	0.045	0.078	0.086	0.053	0.057	0.065	0.056	0.082	0.074	0.048
Tues/Wed/Thurs	17	0.077	0.078	0.041	0.074	0.063	0.050	0.078	0.063	0.054	0.088	0.062	0.040	0.077	0.078	0.041	0.056	0.054	0.051	0.074	0.061	0.036
Tues/Wed/Thurs	18	0.059	0.047	0.030	0.059	0.048	0.044	0.055	0.045	0.047	0.054	0.039	0.031	0.059	0.047	0.030	0.053	0.041	0.045	0.053	0.044	0.023
Tues/Wed/Thurs	19	0.048	0.031	0.027	0.043	0.034	0.038	0.039	0.032	0.040	0.036	0.026	0.023	0.048	0.031	0.027	0.052	0.032	0.039	0.038	0.031	0.016
Tues/Wed/Thurs	20	0.041	0.021	0.020	0.035	0.025	0.034	0.032	0.024	0.035	0.028	0.019	0.021	0.041	0.021	0.020	0.050	0.024	0.036	0.030	0.025	0.012
Tues/Wed/Thurs	21	0.036	0.017	0.020	0.029	0.019	0.031	0.027	0.019	0.032	0.021	0.013	0.020	0.036	0.017	0.020	0.045	0.021	0.030	0.023	0.018	0.010
Tues/Wed/Thurs	22	0.025	0.009	0.014	0.020	0.013	0.029	0.020	0.014	0.028	0.014	0.007	0.016	0.025	0.009	0.014	0.039	0.016	0.027	0.017	0.013	0.010
Tues/Wed/Thurs	23	0.017	0.005	0.012	0.013	0.009	0.028	0.013	0.010	0.025	0.009	0.004	0.013	0.017	0.005	0.012	0.031	0.013	0.025	0.010	0.008	0.010
Friday	0	0.009	0.004	0.008	0.007	0.014	0.032	0.007	0.019	0.030	0.007	0.003	0.011	0.009	0.004	0.008	0.023	0.009	0.025	0.005	0.009	0.019
Friday	1	0.009	0.003	0.009	0.005	0.011	0.030	0.004	0.018	0.030	0.004	0.003	0.012	0.009	0.003	0.009	0.024	0.009	0.022	0.003	0.008	0.019
Friday	2	0.009	0.003	0.011	0.004	0.011	0.030	0.003	0.017	0.029	0.004	0.003	0.015	0.009	0.003	0.011	0.024	0.009	0.021	0.002	0.008	0.019
Friday	3	0.011	0.005	0.016	0.005	0.012	0.030	0.004	0.019	0.031	0.004	0.004	0.017	0.011	0.005	0.016	0.026	0.011	0.023	0.002	0.008	0.021
Friday	4	0.013	0.009	0.022	0.008	0.016	0.033	0.009	0.023	0.034	0.006	0.007	0.024	0.013	0.009	0.022	0.028	0.017	0.027	0.005	0.013	0.024
Friday	5	0.021	0.021	0.039	0.017	0.026	0.038	0.020	0.032	0.039	0.015	0.022	0.039	0.021	0.021	0.039	0.032	0.031	0.034	0.013	0.023	0.037
Friday	6	0.033	0.041	0.054	0.033	0.040	0.045	0.037	0.044	0.046	0.035	0.045	0.055	0.033	0.041	0.054	0.034	0.040	0.040	0.026	0.035	0.049
Friday	7	0.039	0.052	0.065	0.049	0.054	0.050	0.059	0.060	0.053	0.063	0.063	0.064	0.039	0.052	0.065	0.036	0.052	0.049	0.039	0.040	0.060
Friday	8	0.044	0.059	0.074	0.051	0.057	0.052	0.057	0.059	0.053	0.058	0.072	0.074	0.044	0.059	0.074	0.039	0.058	0.051	0.043	0.049	0.068
Friday	9	0.047	0.060	0.078	0.050	0.057	0.052	0.052	0.056	0.052	0.052	0.068	0.075	0.047	0.060	0.078	0.040	0.059	0.056	0.049	0.057	0.073
Friday	10	0.048	0.067	0.075	0.054	0.061	0.054	0.053	0.057	0.052	0.055	0.071	0.074	0.048	0.067	0.075	0.043	0.063	0.060	0.058	0.063	0.078
Friday	11	0.054	0.068	0.077	0.060	0.066	0.055	0.056	0.059	0.053	0.060	0.074	0.074	0.054	0.068	0.077	0.045	0.066	0.064	0.064	0.069	0.077
Friday	12	0.060	0.072	0.079	0.063	0.067	0.055	0.059	0.061	0.053	0.063	0.072	0.069	0.060	0.072	0.079	0.046	0.063	0.065	0.066	0.071	0.076
Friday	13	0.063	0.075	0.072	0.066	0.068	0.054	0.062	0.063	0.054	0.065	0.076	0.069	0.063	0.075	0.072	0.049	0.066	0.063	0.071	0.074	0.077
Friday	14	0.068	0.078	0.067	0.070	0.070	0.054	0.068	0.066	0.055	0.069	0.078	0.063	0.068	0.078	0.067	0.051	0.067	0.059	0.076	0.077	0.070
Friday	15	0.073	0.083	0.060	0.073	0.070	0.052	0.073	0.067	0.055	0.078	0.080	0.055	0.073	0.083	0.060	0.054	0.069	0.057	0.083	0.079	0.060
Friday	16	0.076	0.082	0.049	0.074	0.067	0.050	0.077	0.067	0.053	0.085	0.075	0.047	0.076	0.082	0.049	0.056	0.067	0.053	0.083	0.077	0.050
Friday	17	0.074	0.072	0.038	0.072	0.063	0.047	0.074	0.061	0.050	0.082	0.061	0.039	0.074	0.072	0.038	0.058	0.060	0.048	0.075	0.064	0.038
Friday	18	0.060	0.050	0.026	0.063	0.051	0.042	0.060	0.047	0.043	0.059	0.041	0.029	0.060	0.050	0.026	0.057	0.051	0.042	0.062	0.051	0.025
Friday	19	0.052	0.034	0.024	0.050	0.039	0.035	0.046	0.034	0.036	0.042	0.028	0.024	0.052	0.034	0.024	0.057	0.043	0.038	0.050	0.039	0.018
Friday	20	0.043	0.022	0.017	0.041	0.029	0.030	0.038	0.026	0.030	0.032	0.021	0.021	0.043	0.022	0.017	0.053	0.033	0.033	0.041	0.030	0.013
Friday	21	0.040	0.018	0.016	0.037	0.023	0.028	0.034	0.020	0.026	0.027	0.015	0.020	0.040	0.018	0.016	0.049	0.025	0.027	0.036	0.025	0.010

		Del Norte			El Dorado			Fresno			Glenn			Humboldt			Imperial			Inyo		
Day of Week	**Hour**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**
Friday	22	0.031	0.012	0.011	0.030	0.017	0.026	0.028	0.015	0.023	0.021	0.011	0.016	0.031	0.012	0.011	0.042	0.017	0.023	0.030	0.019	0.011
Friday	23	0.022	0.007	0.012	0.019	0.011	0.024	0.020	0.011	0.020	0.014	0.007	0.015	0.022	0.007	0.012	0.034	0.014	0.020	0.018	0.012	0.009
Saturday	0	0.012	0.008	0.014	0.013	0.019	0.038	0.015	0.028	0.041	0.012	0.007	0.021	0.012	0.008	0.014	0.025	0.018	0.036	0.010	0.015	0.027
Saturday	1	0.013	0.006	0.014	0.008	0.015	0.034	0.010	0.025	0.038	0.008	0.005	0.016	0.013	0.006	0.014	0.027	0.015	0.030	0.007	0.012	0.023
Saturday	2	0.013	0.004	0.011	0.006	0.014	0.032	0.008	0.024	0.037	0.006	0.004	0.020	0.013	0.004	0.011	0.027	0.012	0.024	0.005	0.011	0.022
Saturday	3	0.012	0.004	0.014	0.006	0.013	0.031	0.006	0.023	0.036	0.005	0.004	0.022	0.012	0.004	0.014	0.028	0.015	0.027	0.004	0.010	0.025
Saturday	4	0.014	0.008	0.020	0.007	0.014	0.032	0.009	0.024	0.037	0.006	0.008	0.024	0.014	0.008	0.020	0.031	0.019	0.030	0.005	0.013	0.028
Saturday	5	0.020	0.016	0.034	0.011	0.018	0.034	0.016	0.029	0.040	0.012	0.017	0.039	0.020	0.016	0.034	0.034	0.035	0.037	0.010	0.021	0.034
Saturday	6	0.025	0.025	0.043	0.019	0.026	0.039	0.026	0.036	0.045	0.021	0.028	0.049	0.025	0.025	0.043	0.035	0.038	0.043	0.017	0.028	0.039
Saturday	7	0.030	0.031	0.058	0.032	0.038	0.046	0.036	0.043	0.049	0.034	0.041	0.058	0.030	0.031	0.058	0.038	0.050	0.050	0.029	0.036	0.053
Saturday	8	0.036	0.041	0.070	0.045	0.051	0.052	0.045	0.050	0.052	0.045	0.057	0.067	0.036	0.041	0.070	0.040	0.057	0.055	0.044	0.045	0.060
Saturday	9	0.043	0.053	0.079	0.057	0.062	0.056	0.053	0.055	0.054	0.054	0.068	0.074	0.043	0.053	0.079	0.043	0.064	0.058	0.059	0.061	0.071
Saturday	10	0.052	0.069	0.082	0.067	0.071	0.060	0.060	0.061	0.056	0.063	0.080	0.073	0.052	0.069	0.082	0.044	0.066	0.064	0.073	0.074	0.078
Saturday	11	0.054	0.076	0.075	0.074	0.076	0.061	0.066	0.064	0.056	0.068	0.082	0.071	0.054	0.076	0.075	0.045	0.064	0.069	0.081	0.077	0.083
Saturday	12	0.061	0.080	0.070	0.075	0.075	0.060	0.069	0.065	0.056	0.074	0.083	0.068	0.061	0.080	0.070	0.046	0.063	0.066	0.078	0.077	0.075
Saturday	13	0.063	0.082	0.064	0.075	0.074	0.057	0.069	0.063	0.054	0.074	0.079	0.062	0.063	0.082	0.064	0.049	0.063	0.063	0.075	0.072	0.060
Saturday	14	0.065	0.081	0.062	0.074	0.071	0.055	0.070	0.063	0.053	0.074	0.076	0.057	0.065	0.081	0.062	0.051	0.062	0.059	0.075	0.068	0.055
Saturday	15	0.067	0.080	0.054	0.072	0.068	0.051	0.069	0.060	0.049	0.073	0.074	0.052	0.067	0.080	0.054	0.053	0.062	0.053	0.075	0.068	0.052
Saturday	16	0.071	0.081	0.051	0.070	0.064	0.048	0.067	0.057	0.046	0.073	0.067	0.045	0.071	0.081	0.051	0.053	0.057	0.047	0.072	0.070	0.047
Saturday	17	0.068	0.072	0.037	0.066	0.057	0.044	0.063	0.051	0.042	0.069	0.058	0.039	0.068	0.072	0.037	0.054	0.054	0.039	0.066	0.063	0.040
Saturday	18	0.062	0.053	0.032	0.056	0.047	0.038	0.056	0.044	0.036	0.058	0.047	0.034	0.062	0.053	0.032	0.055	0.048	0.034	0.058	0.052	0.031
Saturday	19	0.059	0.040	0.029	0.046	0.037	0.033	0.047	0.036	0.031	0.046	0.036	0.029	0.059	0.040	0.029	0.052	0.040	0.030	0.047	0.041	0.026
Saturday	20	0.051	0.032	0.021	0.040	0.030	0.028	0.041	0.031	0.027	0.040	0.028	0.024	0.051	0.032	0.021	0.049	0.032	0.026	0.038	0.031	0.020
Saturday	21	0.047	0.026	0.023	0.035	0.025	0.025	0.038	0.027	0.023	0.036	0.022	0.023	0.047	0.026	0.023	0.045	0.025	0.023	0.031	0.025	0.016
Saturday	22	0.037	0.019	0.020	0.028	0.019	0.023	0.034	0.024	0.021	0.029	0.016	0.017	0.037	0.019	0.020	0.040	0.020	0.020	0.025	0.020	0.018
Saturday	23	0.028	0.014	0.021	0.020	0.014	0.021	0.024	0.019	0.019	0.020	0.011	0.017	0.028	0.014	0.021	0.036	0.018	0.016	0.016	0.013	0.018
Holiday	0	0.010	0.004	0.009	0.010	0.016	0.028	0.013	0.023	0.029	0.010	0.004	0.012	0.010	0.004	0.009	0.027	0.013	0.019	0.008	0.011	0.020
Holiday	1	0.014	0.004	0.008	0.006	0.013	0.027	0.007	0.022	0.027	0.006	0.004	0.011	0.014	0.004	0.008	0.028	0.009	0.017	0.005	0.009	0.018
Holiday	2	0.010	0.003	0.014	0.004	0.012	0.026	0.005	0.022	0.027	0.004	0.003	0.012	0.010	0.003	0.014	0.026	0.008	0.018	0.003	0.010	0.018
Holiday	3	0.014	0.005	0.012	0.005	0.013	0.027	0.004	0.021	0.028	0.004	0.005	0.015	0.014	0.005	0.012	0.027	0.010	0.018	0.004	0.010	0.021
Holiday	4	0.014	0.006	0.017	0.008	0.016	0.029	0.008	0.024	0.030	0.007	0.009	0.024	0.014	0.006	0.017	0.030	0.016	0.022	0.005	0.012	0.020
Holiday	5	0.019	0.018	0.028	0.014	0.023	0.032	0.016	0.031	0.034	0.014	0.020	0.037	0.019	0.018	0.028	0.030	0.026	0.029	0.009	0.018	0.031
Holiday	6	0.028	0.034	0.042	0.025	0.033	0.036	0.028	0.039	0.038	0.030	0.036	0.047	0.028	0.034	0.042	0.032	0.032	0.031	0.018	0.023	0.038
Holiday	7	0.039	0.045	0.052	0.036	0.044	0.042	0.040	0.046	0.041	0.044	0.052	0.061	0.039	0.045	0.052	0.036	0.042	0.037	0.029	0.031	0.043
Holiday	8	0.041	0.051	0.059	0.046	0.053	0.048	0.045	0.049	0.043	0.052	0.066	0.075	0.041	0.051	0.059	0.040	0.055	0.044	0.041	0.044	0.056
Holiday	9	0.044	0.057	0.066	0.054	0.059	0.050	0.049	0.052	0.047	0.053	0.071	0.081	0.044	0.057	0.066	0.042	0.061	0.054	0.058	0.057	0.075
Holiday	10	0.050	0.069	0.075	0.065	0.069	0.053	0.057	0.059	0.049	0.059	0.076	0.081	0.050	0.069	0.075	0.045	0.067	0.060	0.076	0.083	0.087
Holiday	11	0.056	0.072	0.077	0.074	0.074	0.057	0.065	0.063	0.051	0.066	0.076	0.071	0.056	0.072	0.077	0.047	0.070	0.068	0.084	0.086	0.088
Holiday	12	0.058	0.080	0.078	0.077	0.074	0.056	0.070	0.067	0.054	0.071	0.078	0.074	0.058	0.080	0.078	0.046	0.069	0.070	0.085	0.087	0.089
Holiday	13	0.063	0.077	0.069	0.076	0.074	0.058	0.072	0.067	0.056	0.071	0.076	0.065	0.063	0.077	0.069	0.053	0.080	0.070	0.083	0.081	0.078
Holiday	14	0.068	0.083	0.067	0.075	0.073	0.056	0.074	0.066	0.055	0.070	0.078	0.060	0.068	0.083	0.067	0.051	0.075	0.068	0.080	0.074	0.068
Holiday	15	0.071	0.082	0.064	0.074	0.070	0.055	0.076	0.067	0.056	0.075	0.075	0.053	0.071	0.082	0.064	0.054	0.067	0.062	0.078	0.074	0.060
Holiday	16	0.075	0.083	0.061	0.072	0.066	0.054	0.076	0.064	0.055	0.079	0.070	0.044	0.075	0.083	0.061	0.056	0.066	0.057	0.078	0.072	0.049
Holiday	17	0.072	0.076	0.044	0.068	0.059	0.051	0.072	0.058	0.052	0.074	0.064	0.041	0.072	0.076	0.044	0.056	0.061	0.054	0.071	0.066	0.041
Holiday	18	0.054	0.048	0.040	0.057	0.049	0.045	0.058	0.046	0.049	0.058	0.044	0.034	0.054	0.048	0.040	0.052	0.047	0.045	0.057	0.049	0.033
Holiday	19	0.056	0.036	0.029	0.047	0.036	0.041	0.047	0.035	0.043	0.047	0.033	0.026	0.056	0.036	0.029	0.053	0.039	0.040	0.043	0.040	0.022
Holiday	20	0.049	0.025	0.029	0.039	0.029	0.037	0.039	0.028	0.040	0.038	0.025	0.025	0.049	0.025	0.029	0.049	0.029	0.035	0.033	0.026	0.013
Holiday	21	0.040	0.019	0.023	0.030	0.020	0.033	0.032	0.022	0.036	0.030	0.018	0.021	0.040	0.019	0.023	0.046	0.022	0.030	0.024	0.018	0.011
Holiday	22	0.029	0.012	0.018	0.023	0.015	0.031	0.026	0.017	0.032	0.024	0.011	0.017	0.029	0.012	0.018	0.042	0.020	0.027	0.017	0.012	0.009
Holiday	23	0.025	0.010	0.019	0.015	0.010	0.029	0.018	0.013	0.029	0.014	0.007	0.014	0.025	0.010	0.019	0.032	0.019	0.025	0.010	0.008	0.010

		Kern			Kings			Lake			Lassen			Los Angeles			Madera			Marin		
Day of Week	**Hour**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**
Sunday	0	0.014	0.028	0.041	0.016	0.031	0.042	0.013	0.011	0.008	0.020	0.007	0.015	0.025	0.043	0.051	0.014	0.037	0.044	0.019	0.038	0.053
Sunday	1	0.010	0.024	0.038	0.010	0.025	0.038	0.013	0.008	0.010	0.020	0.005	0.014	0.018	0.033	0.044	0.008	0.032	0.040	0.012	0.034	0.047
Sunday	2	0.007	0.022	0.034	0.007	0.026	0.036	0.012	0.006	0.008	0.020	0.003	0.012	0.014	0.028	0.040	0.005	0.028	0.037	0.008	0.031	0.043
Sunday	3	0.006	0.020	0.033	0.005	0.022	0.031	0.014	0.005	0.007	0.021	0.004	0.011	0.009	0.022	0.035	0.004	0.026	0.035	0.006	0.030	0.040
Sunday	4	0.007	0.021	0.033	0.004	0.020	0.031	0.014	0.004	0.011	0.024	0.007	0.011	0.008	0.021	0.034	0.004	0.025	0.034	0.006	0.029	0.038
Sunday	5	0.012	0.024	0.033	0.008	0.023	0.031	0.017	0.009	0.019	0.028	0.012	0.015	0.012	0.024	0.035	0.009	0.027	0.034	0.010	0.031	0.038
Sunday	6	0.016	0.027	0.034	0.018	0.029	0.036	0.021	0.014	0.028	0.030	0.017	0.026	0.018	0.029	0.037	0.016	0.030	0.036	0.016	0.033	0.039
Sunday	7	0.024	0.032	0.035	0.023	0.030	0.035	0.026	0.020	0.036	0.034	0.032	0.037	0.025	0.034	0.039	0.022	0.033	0.036	0.023	0.036	0.040
Sunday	8	0.032	0.039	0.038	0.034	0.040	0.040	0.031	0.032	0.043	0.037	0.045	0.053	0.035	0.040	0.042	0.033	0.039	0.040	0.033	0.040	0.042
Sunday	9	0.042	0.045	0.040	0.048	0.049	0.046	0.040	0.050	0.054	0.044	0.064	0.064	0.047	0.050	0.045	0.046	0.047	0.044	0.048	0.046	0.044
Sunday	10	0.051	0.051	0.042	0.059	0.057	0.049	0.047	0.064	0.067	0.046	0.076	0.072	0.057	0.056	0.047	0.056	0.052	0.046	0.062	0.051	0.045
Sunday	11	0.059	0.056	0.045	0.071	0.064	0.052	0.055	0.079	0.062	0.050	0.083	0.079	0.062	0.059	0.047	0.065	0.057	0.048	0.067	0.053	0.046
Sunday	12	0.066	0.060	0.046	0.084	0.077	0.057	0.061	0.087	0.065	0.053	0.088	0.075	0.065	0.060	0.047	0.071	0.059	0.049	0.070	0.054	0.046
Sunday	13	0.071	0.063	0.047	0.083	0.077	0.056	0.065	0.092	0.064	0.054	0.082	0.069	0.068	0.060	0.046	0.073	0.059	0.049	0.073	0.055	0.050
Sunday	14	0.075	0.065	0.047	0.080	0.072	0.055	0.067	0.087	0.065	0.059	0.075	0.067	0.068	0.058	0.044	0.076	0.059	0.048	0.073	0.055	0.047
Sunday	15	0.078	0.064	0.048	0.076	0.065	0.052	0.072	0.086	0.067	0.060	0.076	0.064	0.067	0.055	0.043	0.076	0.058	0.047	0.073	0.053	0.041
Sunday	16	0.077	0.063	0.048	0.074	0.062	0.050	0.077	0.086	0.072	0.063	0.074	0.058	0.065	0.052	0.042	0.077	0.058	0.047	0.072	0.052	0.039
Sunday	17	0.074	0.060	0.047	0.068	0.056	0.046	0.070	0.075	0.058	0.063	0.063	0.058	0.063	0.049	0.040	0.074	0.055	0.046	0.070	0.050	0.038
Sunday	18	0.069	0.055	0.046	0.059	0.044	0.042	0.067	0.059	0.054	0.061	0.053	0.050	0.059	0.045	0.040	0.068	0.048	0.043	0.063	0.047	0.036
Sunday	19	0.061	0.049	0.046	0.050	0.037	0.037	0.062	0.045	0.050	0.059	0.051	0.041	0.056	0.042	0.039	0.060	0.043	0.041	0.056	0.044	0.035
Sunday	20	0.053	0.042	0.045	0.043	0.032	0.037	0.054	0.035	0.047	0.051	0.034	0.036	0.052	0.040	0.040	0.052	0.039	0.040	0.051	0.041	0.036
Sunday	21	0.042	0.035	0.044	0.036	0.028	0.035	0.045	0.024	0.039	0.044	0.025	0.031	0.047	0.038	0.041	0.042	0.034	0.039	0.042	0.038	0.037
Sunday	22	0.032	0.030	0.045	0.028	0.022	0.034	0.033	0.015	0.033	0.035	0.016	0.024	0.036	0.034	0.042	0.031	0.028	0.038	0.030	0.032	0.039
Sunday	23	0.021	0.025	0.046	0.015	0.015	0.033	0.022	0.009	0.032	0.024	0.009	0.018	0.024	0.029	0.042	0.018	0.023	0.037	0.019	0.027	0.043
Monday	0	0.013	0.022	0.025	0.005	0.013	0.019	0.010	0.003	0.007	0.020	0.005	0.012	0.012	0.018	0.025	0.007	0.021	0.024	0.007	0.023	0.029
Monday	1	0.009	0.019	0.024	0.002	0.012	0.019	0.009	0.002	0.007	0.021	0.003	0.010	0.007	0.015	0.023	0.003	0.020	0.024	0.003	0.022	0.028
Monday	2	0.008	0.019	0.024	0.001	0.014	0.020	0.010	0.003	0.010	0.022	0.003	0.012	0.006	0.015	0.023	0.002	0.020	0.024	0.002	0.022	0.029
Monday	3	0.011	0.022	0.026	0.001	0.012	0.019	0.012	0.006	0.012	0.023	0.004	0.012	0.007	0.017	0.024	0.004	0.023	0.026	0.003	0.023	0.030
Monday	4	0.021	0.029	0.028	0.003	0.015	0.021	0.014	0.009	0.013	0.026	0.011	0.013	0.016	0.024	0.030	0.012	0.028	0.029	0.012	0.028	0.035
Monday	5	0.040	0.041	0.033	0.012	0.021	0.027	0.022	0.022	0.026	0.037	0.047	0.021	0.038	0.042	0.038	0.029	0.039	0.036	0.033	0.041	0.042
Monday	6	0.047	0.046	0.034	0.034	0.040	0.038	0.037	0.047	0.044	0.038	0.049	0.030	0.054	0.056	0.044	0.050	0.051	0.044	0.054	0.051	0.048
Monday	7	0.056	0.054	0.038	0.070	0.071	0.056	0.045	0.058	0.058	0.041	0.051	0.035	0.061	0.062	0.049	0.072	0.063	0.051	0.066	0.058	0.053
Monday	8	0.050	0.052	0.038	0.073	0.071	0.056	0.047	0.062	0.067	0.043	0.058	0.047	0.059	0.061	0.049	0.063	0.059	0.049	0.062	0.060	0.055
Monday	9	0.049	0.052	0.039	0.061	0.062	0.053	0.050	0.065	0.078	0.045	0.073	0.058	0.054	0.058	0.049	0.058	0.056	0.049	0.055	0.056	0.054
Monday	10	0.052	0.053	0.042	0.059	0.062	0.054	0.051	0.065	0.080	0.047	0.076	0.068	0.052	0.057	0.050	0.057	0.057	0.051	0.052	0.054	0.053
Monday	11	0.057	0.056	0.044	0.059	0.063	0.056	0.056	0.067	0.083	0.052	0.073	0.077	0.052	0.058	0.051	0.059	0.059	0.053	0.053	0.055	0.054
Monday	12	0.061	0.059	0.046	0.062	0.064	0.056	0.058	0.069	0.081	0.053	0.068	0.073	0.054	0.058	0.052	0.060	0.062	0.055	0.054	0.056	0.054
Monday	13	0.064	0.060	0.049	0.064	0.067	0.058	0.063	0.074	0.076	0.056	0.065	0.066	0.055	0.058	0.052	0.061	0.061	0.054	0.056	0.056	0.054
Monday	14	0.068	0.063	0.052	0.073	0.071	0.064	0.067	0.076	0.074	0.058	0.072	0.066	0.059	0.060	0.052	0.066	0.062	0.057	0.063	0.059	0.056
Monday	15	0.074	0.067	0.057	0.078	0.072	0.064	0.073	0.087	0.062	0.059	0.079	0.061	0.062	0.060	0.052	0.071	0.064	0.058	0.069	0.063	0.058
Monday	16	0.073	0.065	0.058	0.086	0.073	0.062	0.076	0.084	0.053	0.061	0.069	0.053	0.063	0.058	0.051	0.075	0.062	0.057	0.072	0.060	0.052
Monday	17	0.067	0.058	0.057	0.087	0.070	0.062	0.075	0.075	0.040	0.059	0.067	0.054	0.064	0.055	0.050	0.074	0.058	0.055	0.073	0.056	0.047
Monday	18	0.050	0.044	0.053	0.056	0.046	0.053	0.057	0.047	0.032	0.056	0.043	0.048	0.059	0.047	0.047	0.052	0.041	0.047	0.061	0.045	0.039
Monday	19	0.037	0.034	0.049	0.037	0.028	0.038	0.050	0.031	0.029	0.050	0.030	0.044	0.049	0.036	0.042	0.037	0.030	0.039	0.045	0.033	0.031
Monday	20	0.032	0.028	0.048	0.029	0.021	0.033	0.043	0.020	0.021	0.043	0.021	0.036	0.039	0.028	0.038	0.030	0.022	0.034	0.035	0.026	0.026
Monday	21	0.026	0.023	0.048	0.023	0.015	0.029	0.035	0.015	0.020	0.040	0.016	0.037	0.034	0.023	0.037	0.025	0.017	0.031	0.031	0.022	0.024
Monday	22	0.021	0.018	0.044	0.016	0.010	0.024	0.025	0.009	0.014	0.030	0.009	0.035	0.027	0.020	0.036	0.019	0.014	0.027	0.023	0.017	0.023
Monday	23	0.014	0.015	0.042	0.009	0.007	0.021	0.016	0.005	0.013	0.022	0.006	0.030	0.017	0.016	0.035	0.012	0.011	0.024	0.014	0.014	0.025

		Kern			Kings			Lake			Lassen			Los Angeles			Madera			Marin		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Tues/Wed/Thurs	0	0.010	0.021	0.032	0.004	0.013	0.022	0.010	0.004	0.008	0.022	0.004	0.024	0.011	0.019	0.029	0.005	0.020	0.027	0.006	0.022	0.031
Tues/Wed/Thurs	1	0.006	0.019	0.031	0.002	0.012	0.021	0.009	0.003	0.008	0.022	0.004	0.016	0.006	0.016	0.028	0.001	0.019	0.026	0.003	0.021	0.030
Tues/Wed/Thurs	2	0.006	0.019	0.031	0.000	0.011	0.021	0.010	0.002	0.012	0.024	0.003	0.012	0.005	0.016	0.027	0.001	0.019	0.027	0.002	0.021	0.030
Tues/Wed/Thurs	3	0.009	0.022	0.031	0.000	0.012	0.021	0.011	0.005	0.014	0.025	0.005	0.016	0.007	0.017	0.028	0.002	0.022	0.028	0.003	0.023	0.031
Tues/Wed/Thurs	4	0.019	0.029	0.034	0.003	0.014	0.023	0.015	0.010	0.021	0.028	0.011	0.025	0.015	0.025	0.033	0.010	0.027	0.032	0.011	0.028	0.036
Tues/Wed/Thurs	5	0.039	0.041	0.037	0.012	0.021	0.029	0.024	0.024	0.035	0.039	0.045	0.028	0.037	0.042	0.041	0.027	0.037	0.039	0.034	0.040	0.044
Tues/Wed/Thurs	6	0.048	0.046	0.039	0.035	0.040	0.042	0.037	0.048	0.048	0.041	0.045	0.035	0.054	0.056	0.047	0.050	0.050	0.047	0.056	0.052	0.049
Tues/Wed/Thurs	7	0.058	0.053	0.042	0.070	0.066	0.055	0.045	0.059	0.065	0.041	0.054	0.046	0.061	0.062	0.051	0.074	0.063	0.054	0.068	0.059	0.054
Tues/Wed/Thurs	8	0.052	0.052	0.042	0.073	0.071	0.058	0.047	0.063	0.069	0.044	0.061	0.053	0.059	0.062	0.051	0.065	0.059	0.052	0.063	0.060	0.056
Tues/Wed/Thurs	9	0.049	0.050	0.041	0.060	0.062	0.054	0.050	0.064	0.074	0.046	0.067	0.059	0.054	0.058	0.050	0.057	0.057	0.051	0.055	0.055	0.053
Tues/Wed/Thurs	10	0.050	0.051	0.042	0.057	0.060	0.054	0.051	0.065	0.075	0.048	0.069	0.067	0.052	0.057	0.051	0.055	0.057	0.052	0.051	0.053	0.052
Tues/Wed/Thurs	11	0.054	0.054	0.044	0.058	0.063	0.056	0.055	0.065	0.076	0.049	0.069	0.074	0.052	0.057	0.051	0.056	0.058	0.052	0.050	0.054	0.052
Tues/Wed/Thurs	12	0.059	0.056	0.046	0.060	0.064	0.056	0.057	0.068	0.076	0.051	0.069	0.070	0.053	0.057	0.051	0.057	0.059	0.053	0.052	0.055	0.053
Tues/Wed/Thurs	13	0.062	0.058	0.047	0.061	0.064	0.057	0.061	0.070	0.071	0.054	0.071	0.064	0.055	0.058	0.050	0.059	0.060	0.054	0.054	0.056	0.054
Tues/Wed/Thurs	14	0.068	0.062	0.050	0.071	0.070	0.059	0.066	0.074	0.068	0.056	0.072	0.062	0.059	0.059	0.050	0.065	0.063	0.055	0.062	0.059	0.054
Tues/Wed/Thurs	15	0.075	0.067	0.053	0.077	0.072	0.062	0.073	0.084	0.062	0.058	0.073	0.059	0.060	0.058	0.049	0.072	0.064	0.056	0.067	0.063	0.056
Tues/Wed/Thurs	16	0.075	0.066	0.054	0.086	0.073	0.060	0.078	0.086	0.053	0.058	0.070	0.053	0.062	0.056	0.048	0.078	0.064	0.055	0.070	0.060	0.051
Tues/Wed/Thurs	17	0.070	0.060	0.053	0.087	0.072	0.060	0.077	0.078	0.041	0.060	0.071	0.048	0.062	0.053	0.046	0.079	0.061	0.053	0.071	0.057	0.046
Tues/Wed/Thurs	18	0.052	0.046	0.048	0.059	0.051	0.051	0.059	0.047	0.030	0.053	0.043	0.043	0.058	0.046	0.043	0.055	0.043	0.044	0.062	0.047	0.039
Tues/Wed/Thurs	19	0.039	0.036	0.044	0.039	0.032	0.038	0.048	0.031	0.027	0.049	0.034	0.038	0.051	0.036	0.039	0.040	0.031	0.036	0.048	0.035	0.031
Tues/Wed/Thurs	20	0.033	0.030	0.042	0.032	0.023	0.032	0.041	0.021	0.020	0.044	0.025	0.030	0.042	0.028	0.036	0.033	0.024	0.032	0.038	0.027	0.026
Tues/Wed/Thurs	21	0.029	0.025	0.041	0.026	0.017	0.028	0.036	0.017	0.020	0.038	0.018	0.029	0.037	0.024	0.034	0.028	0.019	0.028	0.033	0.022	0.024
Tues/Wed/Thurs	22	0.023	0.020	0.039	0.018	0.011	0.023	0.025	0.009	0.014	0.029	0.011	0.026	0.030	0.020	0.033	0.021	0.014	0.025	0.024	0.017	0.022
Tues/Wed/Thurs	23	0.015	0.017	0.038	0.010	0.007	0.019	0.017	0.005	0.012	0.022	0.006	0.024	0.019	0.016	0.032	0.013	0.011	0.023	0.015	0.013	0.024
Friday	0	0.009	0.021	0.035	0.006	0.014	0.024	0.009	0.004	0.008	0.021	0.005	0.023	0.012	0.021	0.032	0.005	0.020	0.029	0.008	0.022	0.033
Friday	1	0.007	0.019	0.034	0.002	0.012	0.024	0.009	0.003	0.009	0.022	0.004	0.015	0.008	0.017	0.030	0.002	0.019	0.029	0.004	0.021	0.031
Friday	2	0.006	0.019	0.034	0.001	0.011	0.022	0.009	0.003	0.011	0.023	0.003	0.011	0.007	0.017	0.030	0.001	0.019	0.029	0.003	0.022	0.032
Friday	3	0.008	0.021	0.035	0.001	0.013	0.024	0.011	0.005	0.016	0.024	0.004	0.016	0.007	0.018	0.031	0.003	0.021	0.030	0.004	0.023	0.033
Friday	4	0.015	0.027	0.037	0.002	0.015	0.025	0.013	0.009	0.022	0.025	0.007	0.025	0.014	0.025	0.035	0.008	0.026	0.034	0.010	0.028	0.036
Friday	5	0.031	0.037	0.040	0.011	0.021	0.031	0.021	0.021	0.039	0.033	0.027	0.029	0.033	0.040	0.044	0.022	0.036	0.040	0.030	0.039	0.044
Friday	6	0.039	0.043	0.043	0.031	0.039	0.043	0.033	0.041	0.054	0.035	0.034	0.035	0.049	0.054	0.050	0.039	0.047	0.048	0.050	0.049	0.050
Friday	7	0.048	0.050	0.045	0.063	0.064	0.057	0.039	0.052	0.065	0.040	0.046	0.049	0.057	0.060	0.053	0.059	0.058	0.054	0.063	0.057	0.055
Friday	8	0.045	0.050	0.045	0.067	0.069	0.059	0.044	0.059	0.074	0.044	0.061	0.056	0.056	0.060	0.054	0.054	0.058	0.054	0.059	0.057	0.056
Friday	9	0.045	0.049	0.046	0.057	0.062	0.057	0.047	0.060	0.078	0.047	0.068	0.060	0.052	0.058	0.054	0.051	0.056	0.054	0.053	0.054	0.054
Friday	10	0.049	0.053	0.047	0.057	0.063	0.056	0.048	0.067	0.075	0.046	0.068	0.071	0.052	0.058	0.054	0.052	0.057	0.054	0.051	0.053	0.053
Friday	11	0.054	0.055	0.048	0.059	0.065	0.058	0.054	0.068	0.077	0.049	0.075	0.077	0.053	0.059	0.054	0.054	0.059	0.054	0.053	0.055	0.054
Friday	12	0.058	0.057	0.049	0.061	0.064	0.058	0.060	0.072	0.079	0.051	0.071	0.070	0.054	0.059	0.054	0.056	0.060	0.055	0.056	0.057	0.055
Friday	13	0.063	0.060	0.050	0.062	0.066	0.058	0.063	0.075	0.072	0.056	0.074	0.065	0.056	0.059	0.052	0.059	0.062	0.055	0.058	0.058	0.056
Friday	14	0.068	0.063	0.051	0.070	0.069	0.058	0.068	0.078	0.067	0.056	0.074	0.060	0.057	0.059	0.051	0.065	0.063	0.055	0.064	0.059	0.056
Friday	15	0.072	0.067	0.053	0.073	0.069	0.060	0.073	0.083	0.060	0.059	0.074	0.055	0.058	0.057	0.049	0.071	0.064	0.056	0.066	0.062	0.056
Friday	16	0.073	0.064	0.052	0.079	0.073	0.060	0.076	0.082	0.049	0.061	0.072	0.054	0.059	0.055	0.046	0.077	0.062	0.053	0.067	0.059	0.050
Friday	17	0.070	0.059	0.050	0.079	0.065	0.055	0.074	0.072	0.038	0.058	0.066	0.046	0.059	0.051	0.044	0.076	0.057	0.049	0.067	0.055	0.046
Friday	18	0.060	0.048	0.044	0.061	0.050	0.047	0.060	0.050	0.026	0.056	0.051	0.043	0.057	0.045	0.040	0.063	0.046	0.042	0.060	0.047	0.039
Friday	19	0.049	0.039	0.039	0.045	0.034	0.036	0.052	0.034	0.024	0.052	0.043	0.036	0.051	0.037	0.035	0.050	0.035	0.035	0.049	0.036	0.030
Friday	20	0.042	0.032	0.035	0.036	0.023	0.028	0.043	0.022	0.017	0.046	0.032	0.028	0.045	0.029	0.030	0.042	0.026	0.029	0.040	0.029	0.023
Friday	21	0.037	0.027	0.032	0.031	0.017	0.024	0.040	0.018	0.016	0.041	0.021	0.026	0.040	0.024	0.027	0.037	0.021	0.025	0.035	0.023	0.020
Friday	22	0.031	0.023	0.029	0.028	0.013	0.019	0.031	0.012	0.011	0.032	0.013	0.026	0.036	0.021	0.026	0.030	0.015	0.020	0.030	0.019	0.019
Friday	23	0.021	0.018	0.027	0.017	0.008	0.016	0.022	0.007	0.012	0.023	0.008	0.024	0.027	0.017	0.024	0.021	0.012	0.018	0.022	0.015	0.020
Saturday	0	0.016	0.028	0.043	0.013	0.022	0.035	0.012	0.008	0.014	0.024	0.009	0.025	0.020	0.031	0.046	0.012	0.031	0.042	0.015	0.030	0.044
Saturday	1	0.011	0.023	0.041	0.008	0.019	0.032	0.013	0.006	0.014	0.026	0.007	0.015	0.013	0.025	0.041	0.008	0.027	0.039	0.009	0.027	0.040
Saturday	2	0.009	0.022	0.040	0.005	0.017	0.031	0.013	0.004	0.011	0.025	0.004	0.013	0.011	0.023	0.039	0.006	0.025	0.038	0.006	0.026	0.039
Saturday	3	0.009	0.021	0.040	0.003	0.016	0.030	0.012	0.004	0.014	0.026	0.004	0.017	0.008	0.020	0.037	0.005	0.024	0.036	0.005	0.025	0.037

		Kern			Kings			Lake			Lassen			Los Angeles			Madera			Marin		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Saturday	4	0.014	0.025	0.041	0.004	0.016	0.031	0.014	0.008	0.020	0.029	0.007	0.025	0.010	0.022	0.038	0.008	0.027	0.037	0.006	0.027	0.037
Saturday	5	0.027	0.034	0.044	0.010	0.022	0.033	0.020	0.016	0.034	0.035	0.022	0.023	0.017	0.028	0.042	0.017	0.032	0.041	0.013	0.030	0.040
Saturday	6	0.034	0.038	0.045	0.023	0.031	0.041	0.025	0.025	0.043	0.039	0.035	0.033	0.027	0.036	0.046	0.026	0.039	0.046	0.023	0.035	0.042
Saturday	7	0.042	0.045	0.047	0.036	0.041	0.048	0.030	0.031	0.058	0.039	0.041	0.050	0.037	0.046	0.051	0.036	0.045	0.050	0.034	0.041	0.047
Saturday	8	0.050	0.052	0.050	0.045	0.049	0.053	0.036	0.041	0.070	0.044	0.057	0.053	0.046	0.052	0.054	0.047	0.052	0.054	0.046	0.047	0.049
Saturday	9	0.056	0.056	0.052	0.053	0.054	0.057	0.043	0.053	0.079	0.047	0.074	0.065	0.053	0.057	0.056	0.055	0.057	0.056	0.055	0.051	0.050
Saturday	10	0.060	0.057	0.053	0.061	0.063	0.059	0.052	0.069	0.082	0.050	0.080	0.075	0.057	0.060	0.056	0.062	0.062	0.060	0.061	0.054	0.051
Saturday	11	0.063	0.059	0.053	0.067	0.072	0.062	0.054	0.076	0.075	0.050	0.078	0.073	0.060	0.062	0.056	0.067	0.063	0.058	0.065	0.056	0.052
Saturday	12	0.065	0.061	0.052	0.071	0.072	0.064	0.061	0.080	0.070	0.053	0.075	0.066	0.062	0.062	0.054	0.068	0.062	0.056	0.066	0.058	0.055
Saturday	13	0.066	0.061	0.050	0.071	0.069	0.060	0.063	0.082	0.064	0.055	0.070	0.064	0.062	0.060	0.051	0.068	0.059	0.054	0.067	0.059	0.058
Saturday	14	0.067	0.060	0.049	0.071	0.070	0.060	0.065	0.081	0.062	0.053	0.068	0.063	0.062	0.058	0.048	0.068	0.059	0.051	0.067	0.058	0.057
Saturday	15	0.067	0.060	0.048	0.070	0.067	0.055	0.067	0.080	0.054	0.054	0.063	0.059	0.062	0.056	0.045	0.068	0.056	0.049	0.068	0.057	0.051
Saturday	16	0.064	0.056	0.044	0.070	0.061	0.049	0.071	0.081	0.051	0.057	0.064	0.055	0.062	0.053	0.042	0.068	0.054	0.046	0.068	0.056	0.047
Saturday	17	0.058	0.052	0.041	0.066	0.056	0.046	0.068	0.072	0.037	0.055	0.064	0.051	0.060	0.049	0.038	0.064	0.050	0.041	0.067	0.054	0.044
Saturday	18	0.051	0.046	0.036	0.059	0.048	0.038	0.062	0.053	0.032	0.052	0.049	0.044	0.057	0.044	0.034	0.057	0.042	0.035	0.060	0.048	0.036
Saturday	19	0.044	0.037	0.032	0.049	0.036	0.030	0.059	0.040	0.029	0.048	0.039	0.039	0.051	0.037	0.029	0.049	0.034	0.029	0.049	0.041	0.029
Saturday	20	0.039	0.033	0.028	0.043	0.032	0.027	0.051	0.032	0.021	0.046	0.034	0.030	0.046	0.033	0.026	0.043	0.030	0.025	0.043	0.036	0.025
Saturday	21	0.035	0.029	0.026	0.040	0.027	0.022	0.047	0.026	0.023	0.039	0.026	0.026	0.043	0.030	0.024	0.039	0.027	0.022	0.041	0.033	0.024
Saturday	22	0.030	0.024	0.024	0.037	0.024	0.020	0.037	0.019	0.020	0.031	0.020	0.020	0.042	0.029	0.024	0.035	0.024	0.019	0.037	0.029	0.023
Saturday	23	0.023	0.020	0.020	0.024	0.017	0.017	0.028	0.014	0.021	0.023	0.010	0.017	0.033	0.026	0.022	0.025	0.020	0.018	0.028	0.024	0.022
Holiday	0	0.015	0.023	0.028	0.011	0.017	0.026	0.010	0.004	0.009	0.020	0.007	0.015	0.017	0.024	0.031	0.010	0.023	0.027	0.013	0.027	0.034
Holiday	1	0.009	0.021	0.028	0.006	0.018	0.023	0.014	0.004	0.008	0.020	0.003	0.012	0.011	0.020	0.028	0.004	0.024	0.028	0.007	0.026	0.033
Holiday	2	0.007	0.020	0.028	0.002	0.018	0.027	0.010	0.003	0.014	0.025	0.003	0.011	0.009	0.019	0.027	0.002	0.022	0.027	0.004	0.025	0.033
Holiday	3	0.008	0.021	0.028	0.001	0.019	0.027	0.014	0.005	0.012	0.022	0.002	0.016	0.007	0.019	0.028	0.001	0.023	0.028	0.003	0.025	0.033
Holiday	4	0.013	0.024	0.028	0.002	0.015	0.027	0.014	0.006	0.017	0.024	0.004	0.015	0.012	0.023	0.030	0.006	0.026	0.030	0.007	0.029	0.035
Holiday	5	0.027	0.032	0.032	0.010	0.021	0.027	0.019	0.018	0.028	0.031	0.020	0.021	0.024	0.033	0.036	0.016	0.033	0.035	0.017	0.034	0.039
Holiday	6	0.033	0.037	0.033	0.026	0.034	0.037	0.028	0.034	0.042	0.033	0.025	0.028	0.034	0.041	0.040	0.028	0.040	0.039	0.029	0.040	0.044
Holiday	7	0.039	0.043	0.036	0.043	0.046	0.041	0.039	0.045	0.052	0.038	0.036	0.044	0.042	0.047	0.043	0.037	0.045	0.042	0.038	0.045	0.047
Holiday	8	0.043	0.047	0.037	0.050	0.052	0.042	0.041	0.051	0.059	0.044	0.054	0.043	0.045	0.050	0.045	0.044	0.051	0.045	0.045	0.050	0.051
Holiday	9	0.050	0.050	0.040	0.051	0.052	0.050	0.044	0.057	0.066	0.046	0.071	0.064	0.048	0.053	0.047	0.051	0.053	0.048	0.049	0.053	0.052
Holiday	10	0.055	0.055	0.042	0.060	0.067	0.052	0.050	0.069	0.075	0.051	0.088	0.073	0.054	0.058	0.050	0.060	0.060	0.053	0.056	0.056	0.053
Holiday	11	0.064	0.060	0.047	0.067	0.070	0.059	0.056	0.072	0.077	0.053	0.082	0.075	0.058	0.061	0.051	0.068	0.064	0.055	0.062	0.059	0.055
Holiday	12	0.068	0.061	0.050	0.073	0.077	0.064	0.058	0.080	0.078	0.055	0.082	0.072	0.061	0.063	0.053	0.072	0.066	0.056	0.067	0.061	0.056
Holiday	13	0.071	0.066	0.051	0.075	0.072	0.057	0.063	0.077	0.069	0.054	0.078	0.063	0.063	0.064	0.053	0.071	0.067	0.058	0.070	0.062	0.056
Holiday	14	0.073	0.064	0.052	0.076	0.070	0.062	0.068	0.083	0.067	0.060	0.077	0.067	0.064	0.064	0.053	0.073	0.064	0.058	0.073	0.062	0.057
Holiday	15	0.075	0.067	0.055	0.072	0.073	0.063	0.071	0.082	0.064	0.054	0.081	0.062	0.065	0.061	0.051	0.075	0.062	0.054	0.071	0.061	0.054
Holiday	16	0.072	0.064	0.055	0.075	0.066	0.057	0.075	0.083	0.061	0.062	0.077	0.063	0.064	0.057	0.050	0.076	0.060	0.054	0.070	0.057	0.050
Holiday	17	0.066	0.059	0.054	0.071	0.059	0.053	0.072	0.076	0.044	0.061	0.066	0.050	0.063	0.053	0.048	0.073	0.056	0.053	0.067	0.053	0.044
Holiday	18	0.056	0.046	0.049	0.059	0.046	0.048	0.054	0.048	0.040	0.057	0.043	0.042	0.058	0.046	0.045	0.061	0.044	0.046	0.059	0.045	0.038
Holiday	19	0.047	0.042	0.050	0.047	0.032	0.038	0.056	0.036	0.029	0.052	0.035	0.041	0.052	0.038	0.042	0.050	0.035	0.040	0.051	0.036	0.031
Holiday	20	0.039	0.033	0.046	0.040	0.029	0.033	0.049	0.025	0.029	0.043	0.022	0.034	0.047	0.032	0.039	0.043	0.029	0.037	0.046	0.031	0.028
Holiday	21	0.031	0.027	0.046	0.034	0.024	0.033	0.040	0.019	0.023	0.041	0.024	0.036	0.042	0.028	0.038	0.035	0.022	0.032	0.041	0.026	0.026
Holiday	22	0.025	0.021	0.043	0.030	0.015	0.031	0.029	0.012	0.018	0.031	0.011	0.026	0.037	0.025	0.037	0.028	0.018	0.029	0.033	0.021	0.025
Holiday	23	0.016	0.018	0.041	0.018	0.009	0.022	0.025	0.010	0.019	0.022	0.009	0.026	0.025	0.020	0.036	0.018	0.014	0.026	0.021	0.017	0.026

		Mariposa			Mendocino			Merced			Modoc			Mono			Monterey			Napa		
Day of Week	**Hour**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**
Sunday	0	0.010	0.014	0.032	0.013	0.011	0.008	0.014	0.025	0.037	0.019	0.009	0.017	0.010	0.014	0.032	0.019	0.010	0.029	0.017	0.035	0.054
Sunday	1	0.007	0.011	0.024	0.013	0.008	0.010	0.009	0.019	0.032	0.021	0.007	0.014	0.007	0.011	0.024	0.020	0.008	0.023	0.011	0.030	0.047
Sunday	2	0.005	0.011	0.022	0.012	0.006	0.008	0.007	0.016	0.029	0.022	0.006	0.013	0.005	0.011	0.022	0.020	0.007	0.021	0.007	0.028	0.044
Sunday	3	0.004	0.010	0.021	0.014	0.005	0.007	0.005	0.015	0.028	0.022	0.005	0.013	0.004	0.010	0.021	0.020	0.007	0.019	0.006	0.026	0.043
Sunday	4	0.004	0.010	0.020	0.014	0.004	0.011	0.006	0.016	0.028	0.023	0.006	0.013	0.004	0.010	0.020	0.024	0.012	0.019	0.006	0.025	0.038
Sunday	5	0.007	0.013	0.021	0.017	0.009	0.019	0.010	0.019	0.029	0.025	0.008	0.016	0.007	0.013	0.021	0.026	0.017	0.021	0.009	0.027	0.038
Sunday	6	0.012	0.019	0.026	0.021	0.014	0.028	0.015	0.023	0.031	0.028	0.014	0.024	0.012	0.019	0.026	0.029	0.024	0.026	0.014	0.030	0.038
Sunday	7	0.019	0.023	0.029	0.026	0.020	0.036	0.021	0.029	0.035	0.030	0.022	0.034	0.019	0.023	0.029	0.031	0.030	0.034	0.020	0.033	0.039
Sunday	8	0.032	0.035	0.038	0.031	0.032	0.043	0.031	0.038	0.040	0.033	0.036	0.048	0.032	0.035	0.038	0.035	0.038	0.040	0.031	0.038	0.042
Sunday	9	0.051	0.051	0.053	0.040	0.050	0.054	0.043	0.050	0.047	0.036	0.052	0.062	0.051	0.051	0.053	0.038	0.049	0.049	0.047	0.047	0.046
Sunday	10	0.067	0.067	0.071	0.047	0.064	0.067	0.055	0.060	0.051	0.040	0.071	0.075	0.067	0.067	0.071	0.041	0.057	0.057	0.060	0.054	0.046
Sunday	11	0.080	0.081	0.085	0.055	0.079	0.062	0.063	0.065	0.054	0.044	0.082	0.086	0.080	0.081	0.085	0.047	0.068	0.061	0.066	0.056	0.047
Sunday	12	0.083	0.081	0.076	0.061	0.087	0.065	0.070	0.070	0.055	0.049	0.089	0.088	0.083	0.081	0.076	0.051	0.074	0.063	0.067	0.056	0.045
Sunday	13	0.085	0.082	0.074	0.065	0.092	0.064	0.075	0.071	0.056	0.054	0.090	0.080	0.085	0.082	0.074	0.053	0.073	0.065	0.070	0.056	0.042
Sunday	14	0.085	0.083	0.069	0.067	0.087	0.065	0.077	0.069	0.055	0.058	0.089	0.072	0.085	0.083	0.069	0.059	0.078	0.065	0.071	0.057	0.038
Sunday	15	0.084	0.081	0.066	0.072	0.086	0.067	0.078	0.070	0.053	0.063	0.087	0.069	0.084	0.081	0.066	0.061	0.078	0.066	0.071	0.052	0.037
Sunday	16	0.082	0.079	0.060	0.077	0.086	0.072	0.077	0.067	0.052	0.064	0.081	0.059	0.082	0.079	0.060	0.064	0.074	0.060	0.072	0.055	0.036
Sunday	17	0.076	0.070	0.053	0.070	0.075	0.058	0.075	0.062	0.049	0.065	0.066	0.051	0.076	0.070	0.053	0.063	0.068	0.053	0.071	0.052	0.035
Sunday	18	0.064	0.056	0.043	0.067	0.059	0.054	0.068	0.055	0.046	0.065	0.055	0.044	0.064	0.056	0.043	0.064	0.060	0.049	0.068	0.051	0.036
Sunday	19	0.049	0.043	0.035	0.062	0.045	0.050	0.061	0.047	0.042	0.062	0.043	0.036	0.049	0.043	0.035	0.060	0.052	0.046	0.062	0.048	0.037
Sunday	20	0.038	0.033	0.024	0.054	0.035	0.047	0.051	0.039	0.040	0.057	0.032	0.028	0.038	0.033	0.024	0.055	0.043	0.041	0.056	0.046	0.038
Sunday	21	0.026	0.022	0.020	0.045	0.024	0.039	0.041	0.031	0.038	0.049	0.022	0.023	0.026	0.022	0.020	0.050	0.034	0.037	0.046	0.038	0.038
Sunday	22	0.017	0.014	0.017	0.033	0.015	0.033	0.029	0.024	0.036	0.041	0.015	0.019	0.017	0.014	0.017	0.039	0.022	0.031	0.033	0.032	0.043
Sunday	23	0.010	0.010	0.020	0.022	0.009	0.032	0.019	0.019	0.037	0.028	0.012	0.016	0.010	0.010	0.020	0.030	0.016	0.025	0.020	0.027	0.050
Monday	0	0.006	0.010	0.017	0.010	0.003	0.007	0.011	0.017	0.023	0.023	0.007	0.013	0.006	0.010	0.017	0.023	0.006	0.009	0.010	0.024	0.031
Monday	1	0.004	0.009	0.016	0.009	0.002	0.007	0.007	0.015	0.022	0.023	0.006	0.011	0.004	0.009	0.016	0.024	0.007	0.009	0.005	0.023	0.031
Monday	2	0.003	0.009	0.016	0.010	0.003	0.010	0.006	0.015	0.022	0.025	0.007	0.011	0.003	0.009	0.016	0.025	0.009	0.010	0.004	0.022	0.030
Monday	3	0.005	0.011	0.019	0.012	0.006	0.012	0.009	0.018	0.025	0.027	0.010	0.011	0.005	0.011	0.019	0.025	0.011	0.014	0.005	0.023	0.032
Monday	4	0.008	0.017	0.024	0.014	0.009	0.013	0.018	0.027	0.032	0.030	0.015	0.012	0.008	0.017	0.024	0.033	0.023	0.019	0.014	0.030	0.037
Monday	5	0.019	0.028	0.036	0.022	0.022	0.026	0.030	0.039	0.039	0.033	0.022	0.018	0.019	0.028	0.036	0.039	0.042	0.024	0.039	0.041	0.044
Monday	6	0.036	0.041	0.050	0.037	0.047	0.044	0.044	0.051	0.045	0.036	0.034	0.024	0.036	0.041	0.050	0.044	0.060	0.031	0.050	0.049	0.051
Monday	7	0.051	0.044	0.065	0.045	0.058	0.058	0.058	0.058	0.050	0.040	0.043	0.030	0.051	0.044	0.065	0.041	0.056	0.038	0.059	0.058	0.056
Monday	8	0.053	0.056	0.068	0.047	0.062	0.067	0.053	0.058	0.051	0.043	0.054	0.039	0.053	0.056	0.068	0.043	0.058	0.045	0.055	0.056	0.055
Monday	9	0.059	0.065	0.080	0.050	0.065	0.078	0.051	0.059	0.053	0.045	0.067	0.048	0.059	0.065	0.080	0.045	0.063	0.053	0.053	0.057	0.058
Monday	10	0.067	0.074	0.087	0.051	0.065	0.080	0.054	0.062	0.056	0.050	0.074	0.054	0.067	0.074	0.087	0.046	0.065	0.059	0.055	0.060	0.058
Monday	11	0.071	0.075	0.082	0.056	0.067	0.083	0.057	0.064	0.057	0.052	0.075	0.059	0.071	0.075	0.082	0.050	0.066	0.061	0.057	0.058	0.058
Monday	12	0.074	0.074	0.080	0.058	0.069	0.081	0.060	0.064	0.058	0.055	0.078	0.059	0.074	0.074	0.080	0.052	0.068	0.065	0.058	0.060	0.059
Monday	13	0.074	0.075	0.075	0.063	0.074	0.076	0.061	0.064	0.058	0.057	0.081	0.060	0.074	0.075	0.075	0.056	0.069	0.063	0.059	0.059	0.055
Monday	14	0.077	0.076	0.065	0.067	0.076	0.074	0.067	0.066	0.058	0.057	0.081	0.065	0.077	0.076	0.065	0.057	0.070	0.065	0.064	0.058	0.053
Monday	15	0.082	0.076	0.058	0.073	0.087	0.062	0.072	0.065	0.057	0.059	0.080	0.063	0.082	0.076	0.058	0.058	0.070	0.066	0.068	0.058	0.050
Monday	16	0.081	0.073	0.045	0.076	0.084	0.053	0.075	0.063	0.055	0.060	0.072	0.064	0.081	0.073	0.045	0.059	0.067	0.060	0.071	0.058	0.046
Monday	17	0.071	0.059	0.035	0.075	0.075	0.040	0.074	0.055	0.051	0.057	0.059	0.066	0.071	0.059	0.035	0.058	0.062	0.057	0.070	0.054	0.042
Monday	18	0.052	0.042	0.023	0.057	0.047	0.032	0.055	0.042	0.042	0.053	0.045	0.063	0.052	0.042	0.023	0.055	0.043	0.053	0.055	0.041	0.035
Monday	19	0.037	0.030	0.017	0.050	0.031	0.029	0.042	0.031	0.036	0.048	0.032	0.060	0.037	0.030	0.017	0.045	0.029	0.048	0.043	0.032	0.028
Monday	20	0.027	0.022	0.013	0.043	0.020	0.021	0.034	0.023	0.031	0.042	0.022	0.054	0.027	0.022	0.013	0.041	0.022	0.045	0.035	0.026	0.024
Monday	21	0.020	0.016	0.010	0.035	0.015	0.020	0.027	0.018	0.028	0.036	0.016	0.046	0.020	0.016	0.010	0.035	0.017	0.039	0.030	0.022	0.021
Monday	22	0.015	0.012	0.009	0.025	0.009	0.014	0.020	0.014	0.027	0.029	0.012	0.039	0.015	0.012	0.009	0.026	0.011	0.035	0.023	0.018	0.022
Monday	23	0.009	0.007	0.010	0.016	0.005	0.013	0.014	0.011	0.025	0.020	0.008	0.031	0.009	0.007	0.010	0.020	0.007	0.033	0.016	0.015	0.025
Tues/Wed/Thurs	0	0.005	0.009	0.017	0.010	0.004	0.008	0.008	0.016	0.025	0.023	0.007	0.018	0.005	0.009	0.017	0.020	0.006	0.023	0.009	0.023	0.033
Tues/Wed/Thurs	1	0.003	0.008	0.017	0.009	0.003	0.008	0.005	0.014	0.024	0.025	0.006	0.015	0.003	0.008	0.017	0.022	0.007	0.021	0.005	0.021	0.031
Tues/Wed/Thurs	2	0.002	0.009	0.017	0.010	0.002	0.012	0.005	0.014	0.025	0.027	0.006	0.013	0.002	0.009	0.017	0.023	0.007	0.021	0.004	0.021	0.031
Tues/Wed/Thurs	3	0.003	0.010	0.022	0.011	0.005	0.014	0.008	0.018	0.028	0.029	0.009	0.013	0.003	0.010	0.022	0.025	0.010	0.022	0.005	0.022	0.032

		Mariposa			Mendocino			Merced			Modoc			Mono			Monterey			Napa		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Tues/Wed/Thurs	4	0.006	0.014	0.025	0.015	0.010	0.021	0.017	0.026	0.034	0.032	0.014	0.016	0.006	0.014	0.025	0.030	0.019	0.024	0.013	0.028	0.039
Tues/Wed/Thurs	5	0.018	0.027	0.039	0.024	0.024	0.035	0.030	0.039	0.042	0.035	0.021	0.020	0.018	0.027	0.039	0.037	0.037	0.029	0.036	0.040	0.046
Tues/Wed/Thurs	6	0.037	0.042	0.052	0.037	0.048	0.048	0.044	0.050	0.047	0.038	0.033	0.027	0.037	0.042	0.052	0.043	0.057	0.038	0.048	0.048	0.051
Tues/Wed/Thurs	7	0.053	0.047	0.064	0.045	0.059	0.065	0.059	0.059	0.052	0.040	0.046	0.036	0.053	0.047	0.064	0.042	0.057	0.046	0.059	0.056	0.056
Tues/Wed/Thurs	8	0.054	0.056	0.070	0.047	0.063	0.069	0.055	0.058	0.052	0.042	0.056	0.046	0.054	0.056	0.070	0.045	0.062	0.050	0.056	0.057	0.057
Tues/Wed/Thurs	9	0.059	0.068	0.083	0.050	0.064	0.074	0.051	0.059	0.054	0.044	0.066	0.057	0.059	0.068	0.083	0.046	0.063	0.055	0.052	0.055	0.056
Tues/Wed/Thurs	10	0.064	0.069	0.081	0.051	0.065	0.075	0.052	0.060	0.056	0.045	0.071	0.065	0.064	0.069	0.081	0.047	0.061	0.058	0.053	0.057	0.057
Tues/Wed/Thurs	11	0.068	0.069	0.077	0.055	0.065	0.076	0.054	0.061	0.057	0.047	0.076	0.070	0.068	0.069	0.077	0.049	0.065	0.060	0.053	0.058	0.057
Tues/Wed/Thurs	12	0.069	0.071	0.074	0.057	0.068	0.076	0.057	0.062	0.057	0.050	0.076	0.070	0.069	0.071	0.074	0.051	0.066	0.060	0.055	0.058	0.056
Tues/Wed/Thurs	13	0.072	0.073	0.074	0.061	0.070	0.071	0.060	0.063	0.056	0.052	0.077	0.069	0.072	0.073	0.074	0.054	0.069	0.059	0.057	0.060	0.055
Tues/Wed/Thurs	14	0.077	0.076	0.067	0.066	0.074	0.068	0.066	0.065	0.056	0.057	0.081	0.067	0.077	0.076	0.067	0.058	0.072	0.059	0.064	0.061	0.053
Tues/Wed/Thurs	15	0.084	0.078	0.058	0.073	0.084	0.062	0.073	0.066	0.055	0.058	0.078	0.064	0.084	0.078	0.058	0.059	0.072	0.057	0.069	0.061	0.050
Tues/Wed/Thurs	16	0.082	0.074	0.048	0.078	0.086	0.053	0.077	0.064	0.053	0.057	0.072	0.061	0.082	0.074	0.048	0.060	0.070	0.053	0.072	0.058	0.046
Tues/Wed/Thurs	17	0.074	0.061	0.036	0.077	0.078	0.041	0.076	0.057	0.049	0.056	0.060	0.057	0.074	0.061	0.036	0.058	0.063	0.051	0.072	0.055	0.041
Tues/Wed/Thurs	18	0.053	0.044	0.023	0.059	0.047	0.030	0.058	0.044	0.041	0.053	0.046	0.053	0.053	0.044	0.023	0.052	0.044	0.046	0.058	0.044	0.035
Tues/Wed/Thurs	19	0.038	0.031	0.016	0.048	0.031	0.027	0.044	0.032	0.034	0.048	0.033	0.044	0.038	0.031	0.016	0.049	0.032	0.041	0.047	0.035	0.028
Tues/Wed/Thurs	20	0.030	0.025	0.012	0.041	0.021	0.020	0.036	0.025	0.030	0.045	0.025	0.038	0.030	0.025	0.012	0.043	0.024	0.037	0.039	0.029	0.024
Tues/Wed/Thurs	21	0.023	0.018	0.010	0.036	0.017	0.020	0.028	0.019	0.026	0.038	0.018	0.032	0.023	0.018	0.010	0.038	0.018	0.034	0.033	0.022	0.021
Tues/Wed/Thurs	22	0.017	0.013	0.010	0.025	0.009	0.014	0.021	0.014	0.025	0.032	0.014	0.026	0.017	0.013	0.010	0.029	0.011	0.030	0.025	0.018	0.022
Tues/Wed/Thurs	23	0.010	0.008	0.010	0.017	0.005	0.012	0.015	0.012	0.023	0.025	0.010	0.021	0.010	0.008	0.010	0.022	0.008	0.026	0.017	0.015	0.025
Friday	0	0.005	0.009	0.019	0.009	0.004	0.008	0.008	0.016	0.027	0.021	0.007	0.019	0.005	0.009	0.019	0.020	0.006	0.022	0.009	0.022	0.034
Friday	1	0.003	0.008	0.019	0.009	0.003	0.009	0.006	0.014	0.025	0.023	0.006	0.017	0.003	0.008	0.019	0.020	0.006	0.021	0.005	0.022	0.032
Friday	2	0.002	0.008	0.019	0.009	0.003	0.011	0.005	0.014	0.026	0.024	0.007	0.016	0.002	0.008	0.019	0.022	0.007	0.021	0.004	0.021	0.034
Friday	3	0.002	0.008	0.021	0.011	0.005	0.016	0.008	0.017	0.029	0.026	0.009	0.016	0.002	0.008	0.021	0.024	0.009	0.022	0.005	0.022	0.034
Friday	4	0.005	0.013	0.024	0.013	0.009	0.022	0.014	0.024	0.035	0.029	0.013	0.019	0.005	0.013	0.024	0.028	0.018	0.024	0.011	0.026	0.039
Friday	5	0.013	0.023	0.037	0.021	0.021	0.039	0.024	0.035	0.042	0.032	0.018	0.023	0.013	0.023	0.037	0.035	0.033	0.029	0.029	0.038	0.046
Friday	6	0.026	0.035	0.049	0.033	0.041	0.054	0.036	0.045	0.047	0.033	0.030	0.032	0.026	0.035	0.049	0.041	0.050	0.038	0.039	0.045	0.052
Friday	7	0.039	0.040	0.060	0.039	0.052	0.065	0.049	0.053	0.052	0.037	0.039	0.039	0.039	0.040	0.060	0.039	0.049	0.046	0.048	0.051	0.057
Friday	8	0.043	0.049	0.068	0.044	0.059	0.074	0.047	0.054	0.053	0.040	0.051	0.049	0.043	0.049	0.068	0.041	0.056	0.050	0.047	0.051	0.057
Friday	9	0.049	0.057	0.073	0.047	0.060	0.078	0.047	0.056	0.055	0.045	0.063	0.054	0.049	0.057	0.073	0.045	0.058	0.055	0.047	0.055	0.058
Friday	10	0.058	0.063	0.078	0.048	0.067	0.075	0.051	0.060	0.058	0.048	0.069	0.060	0.058	0.063	0.078	0.047	0.062	0.059	0.052	0.057	0.059
Friday	11	0.064	0.069	0.077	0.054	0.068	0.077	0.054	0.062	0.060	0.049	0.072	0.063	0.064	0.069	0.077	0.050	0.067	0.060	0.055	0.058	0.059
Friday	12	0.066	0.071	0.076	0.060	0.072	0.079	0.057	0.063	0.060	0.052	0.074	0.063	0.066	0.071	0.076	0.051	0.067	0.060	0.059	0.060	0.058
Friday	13	0.071	0.074	0.077	0.063	0.075	0.072	0.061	0.065	0.059	0.055	0.077	0.062	0.071	0.074	0.077	0.056	0.071	0.062	0.064	0.061	0.052
Friday	14	0.076	0.077	0.070	0.068	0.078	0.067	0.068	0.067	0.058	0.059	0.080	0.063	0.076	0.077	0.070	0.060	0.075	0.059	0.067	0.061	0.051
Friday	15	0.083	0.079	0.060	0.073	0.083	0.060	0.074	0.067	0.056	0.063	0.081	0.061	0.083	0.079	0.060	0.060	0.074	0.060	0.069	0.061	0.048
Friday	16	0.083	0.077	0.050	0.076	0.082	0.049	0.076	0.064	0.053	0.058	0.075	0.059	0.083	0.077	0.050	0.060	0.070	0.055	0.069	0.058	0.045
Friday	17	0.075	0.064	0.038	0.074	0.072	0.038	0.075	0.058	0.048	0.059	0.063	0.055	0.075	0.064	0.038	0.060	0.064	0.049	0.068	0.051	0.040
Friday	18	0.062	0.051	0.025	0.060	0.050	0.026	0.064	0.048	0.040	0.054	0.052	0.051	0.062	0.051	0.025	0.054	0.049	0.044	0.060	0.046	0.034
Friday	19	0.050	0.039	0.018	0.052	0.034	0.024	0.052	0.037	0.032	0.050	0.036	0.046	0.050	0.039	0.018	0.050	0.036	0.040	0.054	0.039	0.027
Friday	20	0.041	0.030	0.013	0.043	0.022	0.017	0.043	0.029	0.026	0.046	0.030	0.041	0.041	0.030	0.013	0.045	0.028	0.037	0.048	0.033	0.023
Friday	21	0.036	0.025	0.010	0.040	0.018	0.016	0.035	0.022	0.022	0.040	0.022	0.036	0.036	0.025	0.010	0.038	0.021	0.032	0.039	0.026	0.019
Friday	22	0.030	0.019	0.011	0.031	0.012	0.011	0.027	0.016	0.020	0.031	0.016	0.031	0.030	0.019	0.011	0.031	0.015	0.029	0.031	0.020	0.020
Friday	23	0.018	0.012	0.009	0.022	0.007	0.012	0.020	0.012	0.018	0.025	0.012	0.025	0.018	0.012	0.009	0.023	0.010	0.026	0.022	0.016	0.021
Saturday	0	0.010	0.015	0.027	0.012	0.008	0.014	0.015	0.026	0.040	0.026	0.013	0.020	0.010	0.015	0.027	0.023	0.011	0.030	0.014	0.029	0.051
Saturday	1	0.007	0.012	0.023	0.013	0.006	0.014	0.010	0.020	0.035	0.026	0.008	0.016	0.007	0.012	0.023	0.025	0.010	0.027	0.009	0.024	0.044
Saturday	2	0.005	0.011	0.022	0.013	0.004	0.011	0.008	0.018	0.032	0.027	0.007	0.015	0.005	0.011	0.022	0.025	0.009	0.026	0.007	0.022	0.041
Saturday	3	0.004	0.010	0.025	0.012	0.004	0.014	0.008	0.019	0.032	0.030	0.007	0.014	0.004	0.010	0.025	0.027	0.011	0.024	0.006	0.023	0.040
Saturday	4	0.005	0.013	0.028	0.014	0.008	0.020	0.011	0.021	0.035	0.029	0.009	0.016	0.005	0.013	0.028	0.031	0.020	0.025	0.007	0.023	0.041
Saturday	5	0.010	0.021	0.034	0.020	0.016	0.034	0.017	0.028	0.039	0.033	0.015	0.019	0.010	0.021	0.034	0.038	0.034	0.030	0.013	0.029	0.045
Saturday	6	0.017	0.028	0.039	0.025	0.025	0.043	0.025	0.036	0.045	0.036	0.023	0.025	0.017	0.028	0.039	0.038	0.047	0.040	0.021	0.033	0.047
Saturday	7	0.029	0.036	0.053	0.030	0.031	0.058	0.034	0.044	0.050	0.038	0.033	0.036	0.029	0.036	0.053	0.042	0.047	0.046	0.030	0.038	0.053

		Mariposa			Mendocino			Merced			Modoc			Mono			Monterey			Napa		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Saturday	8	0.044	0.045	0.060	0.036	0.041	0.070	0.044	0.053	0.055	0.041	0.047	0.047	0.044	0.045	0.060	0.043	0.055	0.050	0.042	0.046	0.052
Saturday	9	0.059	0.061	0.071	0.043	0.053	0.079	0.054	0.061	0.060	0.045	0.063	0.059	0.059	0.061	0.071	0.047	0.062	0.055	0.054	0.054	0.058
Saturday	10	0.073	0.074	0.078	0.052	0.069	0.082	0.062	0.068	0.063	0.049	0.075	0.067	0.073	0.074	0.078	0.047	0.067	0.062	0.063	0.058	0.055
Saturday	11	0.081	0.077	0.083	0.054	0.076	0.075	0.067	0.071	0.064	0.050	0.084	0.073	0.081	0.077	0.083	0.049	0.068	0.063	0.068	0.060	0.052
Saturday	12	0.078	0.077	0.075	0.061	0.080	0.070	0.069	0.070	0.062	0.053	0.083	0.071	0.078	0.077	0.075	0.055	0.071	0.060	0.069	0.060	0.052
Saturday	13	0.075	0.072	0.060	0.063	0.082	0.064	0.070	0.067	0.058	0.055	0.081	0.069	0.075	0.072	0.060	0.054	0.070	0.059	0.067	0.057	0.047
Saturday	14	0.075	0.068	0.055	0.065	0.081	0.062	0.070	0.064	0.054	0.057	0.076	0.065	0.075	0.068	0.055	0.055	0.066	0.058	0.067	0.057	0.045
Saturday	15	0.075	0.068	0.052	0.067	0.080	0.054	0.069	0.061	0.049	0.060	0.074	0.062	0.075	0.068	0.052	0.055	0.065	0.056	0.067	0.057	0.044
Saturday	16	0.072	0.070	0.047	0.071	0.081	0.051	0.068	0.057	0.045	0.056	0.070	0.058	0.072	0.070	0.047	0.057	0.065	0.052	0.068	0.054	0.038
Saturday	17	0.066	0.063	0.040	0.068	0.072	0.037	0.064	0.051	0.040	0.055	0.061	0.057	0.066	0.063	0.040	0.056	0.053	0.047	0.066	0.054	0.035
Saturday	18	0.058	0.052	0.031	0.062	0.053	0.032	0.056	0.042	0.033	0.051	0.049	0.052	0.058	0.052	0.031	0.052	0.044	0.042	0.060	0.049	0.032
Saturday	19	0.047	0.041	0.026	0.059	0.040	0.029	0.048	0.034	0.027	0.049	0.038	0.045	0.047	0.041	0.026	0.049	0.039	0.039	0.052	0.044	0.030
Saturday	20	0.038	0.031	0.020	0.051	0.032	0.021	0.041	0.029	0.024	0.042	0.031	0.038	0.038	0.031	0.020	0.043	0.031	0.035	0.046	0.040	0.028
Saturday	21	0.031	0.025	0.016	0.047	0.026	0.023	0.037	0.024	0.021	0.037	0.023	0.031	0.031	0.025	0.016	0.038	0.025	0.029	0.042	0.035	0.025
Saturday	22	0.025	0.020	0.018	0.037	0.019	0.020	0.031	0.020	0.019	0.031	0.017	0.026	0.025	0.020	0.018	0.030	0.017	0.026	0.036	0.030	0.023
Saturday	23	0.016	0.013	0.018	0.028	0.014	0.021	0.023	0.016	0.017	0.023	0.012	0.019	0.016	0.013	0.018	0.023	0.011	0.020	0.026	0.024	0.024
Holiday	0	0.008	0.011	0.020	0.010	0.004	0.009	0.013	0.020	0.027	0.024	0.008	0.015	0.008	0.011	0.020	0.024	0.008	0.016	0.014	0.028	0.038
Holiday	1	0.005	0.009	0.018	0.014	0.004	0.008	0.009	0.017	0.025	0.027	0.008	0.012	0.005	0.009	0.018	0.022	0.009	0.015	0.008	0.024	0.033
Holiday	2	0.003	0.010	0.018	0.010	0.003	0.014	0.007	0.015	0.024	0.024	0.008	0.012	0.003	0.010	0.018	0.024	0.007	0.015	0.005	0.026	0.033
Holiday	3	0.004	0.010	0.021	0.014	0.005	0.012	0.007	0.016	0.026	0.029	0.010	0.013	0.004	0.010	0.021	0.024	0.009	0.017	0.004	0.025	0.034
Holiday	4	0.005	0.012	0.020	0.014	0.006	0.017	0.011	0.020	0.029	0.029	0.012	0.014	0.005	0.012	0.020	0.031	0.019	0.019	0.008	0.025	0.035
Holiday	5	0.009	0.018	0.031	0.019	0.018	0.028	0.019	0.028	0.033	0.031	0.016	0.017	0.009	0.018	0.031	0.033	0.029	0.024	0.017	0.030	0.040
Holiday	6	0.018	0.023	0.038	0.028	0.034	0.042	0.027	0.035	0.038	0.037	0.025	0.023	0.018	0.023	0.038	0.038	0.042	0.030	0.024	0.036	0.044
Holiday	7	0.029	0.031	0.043	0.039	0.045	0.052	0.035	0.042	0.042	0.038	0.033	0.031	0.029	0.031	0.043	0.040	0.044	0.037	0.030	0.042	0.049
Holiday	8	0.041	0.044	0.056	0.041	0.051	0.059	0.040	0.048	0.046	0.040	0.049	0.040	0.041	0.044	0.056	0.037	0.050	0.041	0.039	0.047	0.049
Holiday	9	0.058	0.057	0.075	0.044	0.057	0.066	0.048	0.055	0.050	0.043	0.062	0.054	0.058	0.057	0.075	0.046	0.057	0.048	0.048	0.055	0.057
Holiday	10	0.076	0.083	0.087	0.050	0.069	0.075	0.059	0.064	0.055	0.050	0.076	0.060	0.076	0.083	0.087	0.048	0.066	0.056	0.060	0.060	0.056
Holiday	11	0.084	0.086	0.088	0.056	0.072	0.077	0.065	0.070	0.060	0.047	0.084	0.068	0.084	0.086	0.088	0.055	0.077	0.063	0.066	0.064	0.055
Holiday	12	0.085	0.087	0.089	0.058	0.080	0.078	0.069	0.072	0.061	0.053	0.083	0.070	0.085	0.087	0.089	0.052	0.074	0.065	0.068	0.063	0.060
Holiday	13	0.083	0.081	0.078	0.063	0.077	0.069	0.071	0.071	0.061	0.062	0.091	0.067	0.083	0.081	0.078	0.055	0.071	0.069	0.069	0.062	0.055
Holiday	14	0.080	0.074	0.068	0.068	0.083	0.067	0.072	0.069	0.059	0.059	0.087	0.069	0.080	0.074	0.068	0.050	0.071	0.067	0.071	0.060	0.055
Holiday	15	0.078	0.074	0.060	0.071	0.082	0.064	0.073	0.068	0.058	0.057	0.079	0.065	0.078	0.074	0.060	0.061	0.068	0.068	0.071	0.064	0.054
Holiday	16	0.078	0.072	0.049	0.075	0.083	0.061	0.073	0.065	0.055	0.056	0.072	0.062	0.078	0.072	0.049	0.062	0.069	0.058	0.068	0.057	0.046
Holiday	17	0.071	0.066	0.041	0.072	0.076	0.044	0.070	0.057	0.050	0.056	0.058	0.060	0.071	0.066	0.041	0.058	0.062	0.058	0.067	0.055	0.041
Holiday	18	0.057	0.049	0.033	0.054	0.048	0.040	0.060	0.046	0.044	0.053	0.044	0.058	0.057	0.049	0.033	0.054	0.050	0.049	0.061	0.042	0.038
Holiday	19	0.043	0.040	0.022	0.056	0.036	0.029	0.050	0.036	0.039	0.048	0.029	0.049	0.043	0.040	0.022	0.049	0.037	0.047	0.053	0.037	0.029
Holiday	20	0.033	0.026	0.013	0.049	0.025	0.029	0.042	0.029	0.034	0.044	0.024	0.045	0.033	0.026	0.013	0.046	0.032	0.043	0.049	0.029	0.024
Holiday	21	0.024	0.018	0.011	0.040	0.019	0.023	0.034	0.023	0.030	0.040	0.019	0.040	0.024	0.018	0.011	0.040	0.025	0.038	0.042	0.028	0.024
Holiday	22	0.017	0.012	0.009	0.029	0.012	0.018	0.027	0.017	0.028	0.031	0.014	0.030	0.017	0.012	0.009	0.031	0.016	0.032	0.035	0.022	0.025
Holiday	23	0.010	0.008	0.010	0.025	0.010	0.019	0.018	0.014	0.026	0.024	0.009	0.024	0.010	0.008	0.010	0.020	0.008	0.028	0.023	0.018	0.026

		Nevada			Orange			Placer			Plumas			Riverside			Sacramento			San Benito		
Day of Week	**Hour**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**
Sunday	0	0.013	0.020	0.031	0.023	0.045	0.061	0.013	0.020	0.031	0.015	0.010	0.015	0.022	0.036	0.050	0.019	0.031	0.044	0.019	0.010	0.029
Sunday	1	0.008	0.016	0.028	0.015	0.032	0.049	0.008	0.016	0.028	0.010	0.006	0.011	0.015	0.028	0.044	0.013	0.025	0.039	0.020	0.008	0.023
Sunday	2	0.006	0.013	0.026	0.011	0.025	0.041	0.006	0.013	0.026	0.007	0.004	0.012	0.011	0.023	0.040	0.009	0.021	0.036	0.020	0.007	0.021
Sunday	3	0.005	0.012	0.025	0.007	0.019	0.034	0.005	0.012	0.025	0.006	0.004	0.012	0.009	0.020	0.036	0.007	0.019	0.034	0.020	0.007	0.019
Sunday	4	0.005	0.012	0.025	0.007	0.018	0.031	0.005	0.012	0.025	0.006	0.005	0.017	0.009	0.020	0.035	0.008	0.020	0.034	0.024	0.012	0.019
Sunday	5	0.008	0.015	0.027	0.011	0.022	0.034	0.008	0.015	0.027	0.010	0.011	0.029	0.012	0.023	0.036	0.011	0.023	0.034	0.026	0.017	0.021
Sunday	6	0.013	0.020	0.030	0.018	0.029	0.038	0.013	0.020	0.030	0.016	0.017	0.037	0.019	0.029	0.039	0.017	0.027	0.037	0.029	0.024	0.026
Sunday	7	0.022	0.028	0.034	0.026	0.036	0.041	0.022	0.028	0.034	0.023	0.029	0.051	0.026	0.035	0.041	0.025	0.033	0.039	0.031	0.030	0.034
Sunday	8	0.034	0.041	0.040	0.037	0.046	0.046	0.034	0.041	0.040	0.033	0.043	0.071	0.036	0.045	0.044	0.035	0.042	0.043	0.035	0.038	0.040
Sunday	9	0.048	0.055	0.046	0.050	0.058	0.051	0.048	0.055	0.046	0.047	0.063	0.091	0.049	0.054	0.047	0.049	0.052	0.047	0.038	0.049	0.049
Sunday	10	0.064	0.068	0.052	0.059	0.065	0.052	0.064	0.068	0.052	0.057	0.075	0.084	0.057	0.061	0.047	0.060	0.060	0.049	0.041	0.057	0.057
Sunday	11	0.075	0.075	0.055	0.065	0.067	0.052	0.075	0.075	0.055	0.067	0.083	0.079	0.064	0.065	0.048	0.066	0.063	0.049	0.047	0.068	0.061
Sunday	12	0.082	0.079	0.058	0.068	0.066	0.049	0.082	0.079	0.058	0.074	0.090	0.070	0.067	0.066	0.047	0.072	0.066	0.049	0.051	0.074	0.063
Sunday	13	0.084	0.079	0.058	0.069	0.064	0.046	0.084	0.079	0.058	0.078	0.089	0.061	0.069	0.065	0.045	0.074	0.067	0.049	0.053	0.073	0.065
Sunday	14	0.084	0.077	0.057	0.068	0.059	0.043	0.084	0.077	0.057	0.079	0.081	0.057	0.069	0.063	0.044	0.074	0.064	0.047	0.059	0.078	0.065
Sunday	15	0.082	0.073	0.057	0.068	0.055	0.040	0.082	0.073	0.057	0.080	0.079	0.053	0.068	0.060	0.042	0.072	0.061	0.046	0.061	0.078	0.066
Sunday	16	0.079	0.068	0.055	0.067	0.051	0.038	0.079	0.068	0.055	0.079	0.075	0.045	0.067	0.056	0.041	0.071	0.059	0.045	0.064	0.074	0.060
Sunday	17	0.072	0.062	0.053	0.064	0.047	0.036	0.072	0.062	0.053	0.075	0.066	0.043	0.064	0.052	0.040	0.068	0.056	0.043	0.063	0.068	0.053
Sunday	18	0.060	0.052	0.049	0.060	0.041	0.034	0.060	0.052	0.049	0.066	0.054	0.039	0.061	0.047	0.039	0.061	0.049	0.041	0.064	0.060	0.049
Sunday	19	0.050	0.043	0.045	0.055	0.036	0.033	0.050	0.043	0.045	0.055	0.042	0.037	0.057	0.042	0.039	0.053	0.042	0.040	0.060	0.052	0.046
Sunday	20	0.041	0.035	0.042	0.052	0.034	0.034	0.041	0.035	0.042	0.045	0.031	0.030	0.053	0.037	0.039	0.048	0.038	0.039	0.055	0.043	0.041
Sunday	21	0.031	0.026	0.039	0.045	0.032	0.036	0.031	0.026	0.039	0.035	0.022	0.024	0.044	0.031	0.039	0.040	0.032	0.039	0.050	0.034	0.037
Sunday	22	0.021	0.019	0.036	0.034	0.028	0.038	0.021	0.019	0.036	0.023	0.013	0.018	0.032	0.024	0.038	0.029	0.027	0.038	0.039	0.022	0.031
Sunday	23	0.013	0.015	0.033	0.022	0.024	0.042	0.013	0.015	0.033	0.014	0.008	0.015	0.021	0.018	0.038	0.019	0.023	0.039	0.030	0.016	0.025
Monday	0	0.008	0.014	0.027	0.010	0.016	0.024	0.008	0.014	0.027	0.006	0.002	0.006	0.011	0.018	0.027	0.009	0.018	0.028	0.023	0.006	0.009
Monday	1	0.005	0.012	0.025	0.006	0.012	0.021	0.005	0.012	0.025	0.004	0.002	0.007	0.008	0.016	0.026	0.005	0.015	0.026	0.024	0.007	0.009
Monday	2	0.004	0.012	0.025	0.005	0.012	0.021	0.004	0.012	0.025	0.003	0.002	0.010	0.007	0.016	0.027	0.004	0.015	0.026	0.025	0.009	0.010
Monday	3	0.006	0.014	0.027	0.006	0.013	0.022	0.006	0.014	0.027	0.003	0.004	0.012	0.011	0.020	0.030	0.006	0.018	0.028	0.025	0.011	0.014
Monday	4	0.011	0.019	0.030	0.015	0.022	0.029	0.011	0.019	0.030	0.007	0.009	0.021	0.024	0.033	0.038	0.013	0.026	0.033	0.033	0.023	0.019
Monday	5	0.023	0.030	0.036	0.034	0.041	0.043	0.023	0.030	0.036	0.018	0.024	0.037	0.040	0.049	0.045	0.029	0.040	0.040	0.039	0.042	0.024
Monday	6	0.042	0.047	0.043	0.054	0.060	0.054	0.042	0.047	0.043	0.041	0.051	0.055	0.053	0.059	0.049	0.052	0.057	0.048	0.044	0.060	0.031
Monday	7	0.060	0.061	0.048	0.066	0.073	0.060	0.060	0.061	0.048	0.078	0.069	0.066	0.059	0.064	0.051	0.071	0.066	0.051	0.041	0.056	0.038
Monday	8	0.059	0.062	0.050	0.064	0.073	0.061	0.059	0.062	0.050	0.067	0.077	0.077	0.056	0.062	0.052	0.066	0.064	0.052	0.043	0.058	0.045
Monday	9	0.056	0.061	0.050	0.056	0.065	0.058	0.056	0.061	0.050	0.057	0.071	0.080	0.053	0.059	0.051	0.056	0.059	0.052	0.045	0.063	0.053
Monday	10	0.058	0.064	0.051	0.052	0.061	0.055	0.058	0.064	0.051	0.057	0.071	0.077	0.052	0.058	0.051	0.052	0.057	0.052	0.046	0.065	0.059
Monday	11	0.062	0.066	0.053	0.052	0.060	0.055	0.062	0.066	0.053	0.060	0.074	0.073	0.053	0.058	0.052	0.053	0.058	0.053	0.050	0.066	0.061
Monday	12	0.066	0.068	0.054	0.053	0.060	0.054	0.066	0.068	0.054	0.063	0.072	0.071	0.055	0.058	0.051	0.056	0.059	0.053	0.052	0.068	0.065
Monday	13	0.067	0.067	0.054	0.055	0.059	0.053	0.067	0.067	0.054	0.063	0.072	0.068	0.057	0.059	0.051	0.057	0.059	0.053	0.056	0.069	0.063
Monday	14	0.070	0.069	0.055	0.060	0.061	0.054	0.070	0.069	0.055	0.067	0.077	0.064	0.061	0.060	0.051	0.062	0.060	0.053	0.057	0.070	0.065
Monday	15	0.073	0.069	0.055	0.064	0.061	0.053	0.073	0.069	0.055	0.078	0.080	0.056	0.065	0.061	0.050	0.070	0.064	0.052	0.058	0.070	0.066
Monday	16	0.075	0.067	0.054	0.067	0.060	0.052	0.075	0.067	0.054	0.086	0.077	0.049	0.067	0.059	0.049	0.076	0.063	0.051	0.059	0.067	0.060
Monday	17	0.073	0.061	0.052	0.068	0.057	0.050	0.073	0.061	0.052	0.087	0.062	0.041	0.066	0.054	0.047	0.073	0.057	0.048	0.058	0.062	0.057
Monday	18	0.056	0.046	0.045	0.060	0.044	0.042	0.056	0.046	0.045	0.051	0.038	0.030	0.056	0.043	0.042	0.056	0.044	0.043	0.055	0.043	0.053
Monday	19	0.040	0.031	0.039	0.047	0.029	0.034	0.040	0.031	0.039	0.036	0.024	0.024	0.044	0.031	0.037	0.040	0.031	0.037	0.045	0.029	0.048
Monday	20	0.031	0.022	0.035	0.037	0.020	0.028	0.031	0.022	0.035	0.026	0.018	0.023	0.035	0.023	0.033	0.032	0.024	0.033	0.041	0.022	0.045
Monday	21	0.025	0.017	0.032	0.032	0.017	0.026	0.025	0.017	0.032	0.020	0.012	0.021	0.030	0.017	0.031	0.028	0.019	0.030	0.035	0.017	0.039
Monday	22	0.017	0.012	0.030	0.024	0.013	0.025	0.017	0.012	0.030	0.013	0.007	0.017	0.023	0.012	0.029	0.021	0.015	0.028	0.026	0.011	0.035
Monday	23	0.012	0.009	0.030	0.015	0.010	0.026	0.012	0.009	0.030	0.008	0.004	0.015	0.016	0.009	0.028	0.014	0.011	0.027	0.020	0.007	0.033
Tues/Wed/Thurs	0	0.008	0.014	0.029	0.009	0.015	0.026	0.008	0.014	0.029	0.006	0.003	0.010	0.010	0.017	0.030	0.008	0.018	0.031	0.020	0.006	0.023
Tues/Wed/Thurs	1	0.004	0.011	0.027	0.005	0.012	0.024	0.004	0.011	0.027	0.003	0.002	0.011	0.007	0.015	0.029	0.005	0.015	0.030	0.022	0.007	0.021
Tues/Wed/Thurs	2	0.004	0.011	0.027	0.004	0.012	0.023	0.004	0.011	0.027	0.003	0.002	0.013	0.006	0.015	0.029	0.004	0.015	0.029	0.023	0.007	0.021
Tues/Wed/Thurs	3	0.005	0.013	0.029	0.005	0.013	0.025	0.005	0.013	0.029	0.003	0.003	0.015	0.010	0.019	0.032	0.006	0.017	0.031	0.025	0.010	0.022

		Nevada			Orange			Placer			Plumas			Riverside			Sacramento			San Benito		
Day of Week	**Hour**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**
Tues/Wed/Thurs	4	0.010	0.018	0.031	0.013	0.022	0.031	0.010	0.018	0.031	0.006	0.008	0.022	0.022	0.032	0.040	0.012	0.024	0.036	0.030	0.019	0.024
Tues/Wed/Thurs	5	0.022	0.029	0.037	0.033	0.040	0.045	0.022	0.029	0.037	0.017	0.024	0.037	0.039	0.048	0.047	0.027	0.038	0.043	0.037	0.037	0.029
Tues/Wed/Thurs	6	0.042	0.047	0.044	0.054	0.061	0.057	0.042	0.047	0.044	0.041	0.053	0.054	0.053	0.060	0.051	0.052	0.057	0.050	0.043	0.057	0.038
Tues/Wed/Thurs	7	0.060	0.061	0.050	0.065	0.073	0.062	0.060	0.061	0.050	0.077	0.069	0.066	0.059	0.064	0.053	0.071	0.066	0.053	0.042	0.057	0.046
Tues/Wed/Thurs	8	0.060	0.062	0.051	0.063	0.073	0.062	0.060	0.062	0.051	0.066	0.077	0.077	0.056	0.062	0.053	0.066	0.063	0.053	0.045	0.062	0.050
Tues/Wed/Thurs	9	0.055	0.060	0.050	0.057	0.066	0.059	0.055	0.060	0.050	0.057	0.071	0.080	0.052	0.059	0.052	0.056	0.059	0.053	0.046	0.063	0.055
Tues/Wed/Thurs	10	0.056	0.061	0.051	0.052	0.061	0.056	0.056	0.061	0.051	0.056	0.071	0.077	0.051	0.058	0.052	0.051	0.057	0.053	0.047	0.061	0.058
Tues/Wed/Thurs	11	0.059	0.064	0.052	0.052	0.061	0.054	0.059	0.064	0.052	0.058	0.071	0.074	0.051	0.058	0.051	0.052	0.057	0.053	0.049	0.065	0.060
Tues/Wed/Thurs	12	0.061	0.065	0.053	0.053	0.060	0.053	0.061	0.065	0.053	0.062	0.070	0.069	0.053	0.058	0.051	0.054	0.058	0.053	0.051	0.066	0.060
Tues/Wed/Thurs	13	0.064	0.066	0.053	0.055	0.060	0.052	0.064	0.066	0.053	0.063	0.073	0.067	0.056	0.059	0.051	0.056	0.059	0.052	0.054	0.069	0.059
Tues/Wed/Thurs	14	0.068	0.068	0.053	0.059	0.061	0.052	0.068	0.068	0.053	0.066	0.076	0.063	0.060	0.061	0.050	0.061	0.061	0.051	0.058	0.072	0.059
Tues/Wed/Thurs	15	0.073	0.069	0.053	0.063	0.061	0.051	0.073	0.069	0.053	0.079	0.080	0.056	0.064	0.061	0.048	0.070	0.064	0.050	0.059	0.072	0.057
Tues/Wed/Thurs	16	0.075	0.067	0.052	0.065	0.059	0.049	0.075	0.067	0.052	0.087	0.076	0.045	0.066	0.060	0.047	0.075	0.063	0.048	0.060	0.070	0.053
Tues/Wed/Thurs	17	0.074	0.063	0.050	0.066	0.055	0.046	0.074	0.063	0.050	0.088	0.062	0.040	0.066	0.055	0.044	0.073	0.057	0.044	0.058	0.063	0.051
Tues/Wed/Thurs	18	0.059	0.048	0.044	0.060	0.044	0.040	0.059	0.048	0.044	0.054	0.039	0.031	0.058	0.045	0.040	0.059	0.046	0.041	0.052	0.044	0.046
Tues/Wed/Thurs	19	0.043	0.034	0.038	0.049	0.030	0.032	0.043	0.034	0.038	0.036	0.026	0.023	0.046	0.032	0.035	0.041	0.033	0.035	0.049	0.032	0.041
Tues/Wed/Thurs	20	0.035	0.025	0.034	0.040	0.021	0.027	0.035	0.025	0.034	0.028	0.019	0.021	0.038	0.024	0.032	0.034	0.026	0.031	0.043	0.024	0.037
Tues/Wed/Thurs	21	0.029	0.019	0.031	0.035	0.017	0.025	0.029	0.019	0.031	0.021	0.013	0.020	0.033	0.018	0.029	0.030	0.021	0.029	0.038	0.018	0.034
Tues/Wed/Thurs	22	0.020	0.013	0.029	0.026	0.013	0.024	0.020	0.013	0.029	0.014	0.007	0.016	0.025	0.012	0.027	0.022	0.016	0.027	0.029	0.011	0.030
Tues/Wed/Thurs	23	0.013	0.009	0.028	0.016	0.010	0.025	0.013	0.009	0.028	0.009	0.004	0.013	0.017	0.008	0.026	0.015	0.012	0.027	0.022	0.008	0.026
Friday	0	0.007	0.014	0.032	0.010	0.017	0.029	0.007	0.014	0.032	0.007	0.003	0.011	0.011	0.018	0.031	0.009	0.019	0.034	0.020	0.006	0.022
Friday	1	0.005	0.011	0.030	0.006	0.014	0.026	0.005	0.011	0.030	0.004	0.003	0.012	0.007	0.015	0.030	0.005	0.016	0.032	0.020	0.006	0.021
Friday	2	0.004	0.011	0.030	0.005	0.013	0.025	0.004	0.011	0.030	0.004	0.003	0.015	0.007	0.016	0.030	0.004	0.016	0.031	0.022	0.007	0.021
Friday	3	0.005	0.012	0.030	0.006	0.014	0.026	0.005	0.012	0.030	0.004	0.004	0.017	0.009	0.019	0.033	0.006	0.017	0.033	0.024	0.009	0.022
Friday	4	0.008	0.016	0.033	0.013	0.021	0.032	0.008	0.016	0.033	0.006	0.007	0.024	0.020	0.030	0.041	0.011	0.024	0.037	0.028	0.018	0.024
Friday	5	0.017	0.026	0.038	0.029	0.038	0.045	0.017	0.026	0.038	0.015	0.022	0.039	0.034	0.045	0.048	0.024	0.036	0.044	0.035	0.033	0.029
Friday	6	0.033	0.040	0.045	0.048	0.057	0.057	0.033	0.040	0.045	0.035	0.045	0.055	0.046	0.055	0.052	0.045	0.053	0.051	0.041	0.050	0.038
Friday	7	0.049	0.054	0.050	0.061	0.070	0.063	0.049	0.054	0.050	0.063	0.063	0.064	0.053	0.061	0.054	0.063	0.063	0.054	0.039	0.049	0.046
Friday	8	0.051	0.057	0.052	0.059	0.070	0.063	0.051	0.057	0.052	0.058	0.072	0.074	0.051	0.059	0.054	0.059	0.061	0.055	0.041	0.056	0.050
Friday	9	0.050	0.057	0.052	0.054	0.064	0.060	0.050	0.057	0.052	0.052	0.068	0.075	0.050	0.058	0.053	0.052	0.058	0.054	0.045	0.058	0.055
Friday	10	0.054	0.061	0.054	0.052	0.062	0.058	0.054	0.061	0.054	0.055	0.071	0.074	0.051	0.059	0.053	0.050	0.057	0.054	0.047	0.062	0.059
Friday	11	0.060	0.066	0.055	0.054	0.062	0.057	0.060	0.066	0.055	0.060	0.074	0.074	0.053	0.060	0.053	0.053	0.059	0.054	0.050	0.067	0.060
Friday	12	0.063	0.067	0.055	0.055	0.062	0.056	0.063	0.067	0.055	0.063	0.072	0.069	0.055	0.061	0.053	0.056	0.060	0.053	0.051	0.067	0.060
Friday	13	0.066	0.068	0.054	0.057	0.062	0.055	0.066	0.068	0.054	0.065	0.076	0.069	0.058	0.061	0.052	0.058	0.060	0.052	0.056	0.071	0.062
Friday	14	0.070	0.070	0.054	0.060	0.062	0.053	0.070	0.070	0.054	0.069	0.078	0.063	0.061	0.062	0.050	0.063	0.062	0.051	0.060	0.075	0.059
Friday	15	0.073	0.070	0.052	0.061	0.060	0.051	0.073	0.070	0.052	0.078	0.080	0.055	0.062	0.061	0.048	0.070	0.063	0.049	0.060	0.074	0.060
Friday	16	0.074	0.067	0.050	0.063	0.057	0.048	0.074	0.067	0.050	0.085	0.075	0.047	0.063	0.058	0.046	0.072	0.060	0.046	0.060	0.070	0.055
Friday	17	0.072	0.063	0.047	0.063	0.053	0.044	0.072	0.063	0.047	0.082	0.061	0.039	0.062	0.053	0.043	0.069	0.055	0.043	0.060	0.064	0.049
Friday	18	0.063	0.051	0.042	0.058	0.042	0.036	0.063	0.051	0.042	0.059	0.041	0.029	0.058	0.045	0.039	0.060	0.046	0.039	0.054	0.049	0.044
Friday	19	0.050	0.039	0.035	0.050	0.031	0.030	0.050	0.039	0.035	0.042	0.028	0.024	0.050	0.035	0.034	0.046	0.035	0.033	0.050	0.036	0.040
Friday	20	0.041	0.029	0.030	0.042	0.023	0.024	0.041	0.029	0.030	0.032	0.021	0.021	0.043	0.026	0.030	0.038	0.026	0.028	0.045	0.028	0.037
Friday	21	0.037	0.023	0.028	0.038	0.018	0.022	0.037	0.023	0.028	0.027	0.015	0.020	0.039	0.020	0.027	0.035	0.022	0.026	0.038	0.021	0.032
Friday	22	0.030	0.017	0.026	0.033	0.015	0.021	0.030	0.017	0.026	0.021	0.011	0.016	0.032	0.014	0.024	0.029	0.018	0.024	0.031	0.015	0.029
Friday	23	0.019	0.011	0.024	0.024	0.012	0.021	0.019	0.011	0.024	0.014	0.007	0.015	0.023	0.009	0.021	0.020	0.013	0.023	0.023	0.010	0.026
Saturday	0	0.013	0.019	0.038	0.017	0.030	0.049	0.013	0.019	0.038	0.012	0.007	0.021	0.017	0.027	0.047	0.016	0.027	0.046	0.023	0.011	0.030
Saturday	1	0.008	0.015	0.034	0.011	0.022	0.041	0.008	0.015	0.034	0.008	0.005	0.016	0.012	0.021	0.042	0.011	0.022	0.042	0.025	0.010	0.027
Saturday	2	0.006	0.014	0.032	0.009	0.019	0.037	0.006	0.014	0.032	0.006	0.004	0.020	0.010	0.019	0.040	0.008	0.020	0.039	0.025	0.009	0.026
Saturday	3	0.006	0.013	0.031	0.007	0.016	0.034	0.006	0.013	0.031	0.005	0.004	0.022	0.009	0.019	0.039	0.007	0.019	0.038	0.027	0.011	0.024
Saturday	4	0.007	0.014	0.032	0.009	0.018	0.036	0.007	0.014	0.032	0.006	0.008	0.024	0.012	0.021	0.041	0.009	0.022	0.039	0.031	0.020	0.025
Saturday	5	0.011	0.018	0.034	0.015	0.026	0.042	0.011	0.018	0.034	0.012	0.017	0.039	0.018	0.029	0.045	0.014	0.027	0.042	0.038	0.034	0.030
Saturday	6	0.019	0.026	0.039	0.026	0.037	0.050	0.019	0.026	0.039	0.021	0.028	0.049	0.028	0.039	0.050	0.023	0.035	0.046	0.038	0.047	0.040
Saturday	7	0.032	0.038	0.046	0.037	0.049	0.058	0.032	0.038	0.046	0.034	0.041	0.058	0.039	0.048	0.055	0.034	0.044	0.050	0.042	0.047	0.046

		Nevada			Orange			Placer			Plumas			Riverside			Sacramento			San Benito		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Saturday	8	0.045	0.051	0.052	0.048	0.060	0.064	0.045	0.051	0.052	0.045	0.057	0.067	0.047	0.056	0.056	0.045	0.052	0.053	0.043	0.055	0.050
Saturday	9	0.057	0.062	0.056	0.055	0.065	0.065	0.057	0.062	0.056	0.054	0.068	0.074	0.054	0.062	0.057	0.054	0.059	0.055	0.047	0.062	0.055
Saturday	10	0.067	0.071	0.060	0.059	0.068	0.064	0.067	0.071	0.060	0.063	0.080	0.073	0.058	0.064	0.056	0.061	0.063	0.055	0.047	0.067	0.062
Saturday	11	0.074	0.076	0.061	0.062	0.069	0.062	0.074	0.076	0.061	0.068	0.082	0.071	0.062	0.066	0.054	0.066	0.065	0.055	0.049	0.068	0.063
Saturday	12	0.075	0.075	0.060	0.064	0.068	0.058	0.075	0.075	0.060	0.074	0.083	0.068	0.063	0.065	0.052	0.068	0.065	0.053	0.055	0.071	0.060
Saturday	13	0.075	0.074	0.057	0.064	0.064	0.053	0.075	0.074	0.057	0.074	0.079	0.062	0.064	0.064	0.050	0.068	0.064	0.051	0.054	0.070	0.059
Saturday	14	0.074	0.071	0.055	0.064	0.061	0.048	0.074	0.071	0.055	0.074	0.076	0.057	0.064	0.062	0.047	0.068	0.061	0.048	0.055	0.066	0.058
Saturday	15	0.072	0.068	0.051	0.064	0.057	0.044	0.072	0.068	0.051	0.073	0.074	0.052	0.064	0.059	0.044	0.067	0.059	0.045	0.055	0.065	0.056
Saturday	16	0.070	0.064	0.048	0.064	0.053	0.039	0.070	0.064	0.048	0.073	0.067	0.045	0.063	0.056	0.041	0.067	0.056	0.042	0.057	0.065	0.052
Saturday	17	0.066	0.057	0.044	0.062	0.048	0.034	0.066	0.057	0.044	0.069	0.058	0.039	0.061	0.051	0.037	0.064	0.052	0.039	0.056	0.053	0.047
Saturday	18	0.056	0.047	0.038	0.057	0.041	0.028	0.056	0.047	0.038	0.058	0.047	0.034	0.056	0.043	0.033	0.057	0.045	0.034	0.052	0.044	0.042
Saturday	19	0.046	0.037	0.033	0.050	0.032	0.022	0.046	0.037	0.033	0.046	0.036	0.029	0.049	0.035	0.028	0.048	0.037	0.030	0.049	0.039	0.039
Saturday	20	0.040	0.030	0.028	0.044	0.027	0.018	0.040	0.030	0.028	0.040	0.028	0.024	0.044	0.030	0.024	0.042	0.031	0.027	0.043	0.031	0.035
Saturday	21	0.035	0.025	0.025	0.042	0.026	0.018	0.035	0.025	0.025	0.036	0.022	0.023	0.042	0.026	0.022	0.040	0.029	0.025	0.038	0.025	0.029
Saturday	22	0.028	0.019	0.023	0.040	0.025	0.018	0.028	0.019	0.023	0.029	0.016	0.017	0.037	0.022	0.020	0.036	0.026	0.024	0.030	0.017	0.026
Saturday	23	0.020	0.014	0.021	0.030	0.021	0.019	0.020	0.014	0.021	0.020	0.011	0.017	0.029	0.017	0.018	0.026	0.020	0.022	0.023	0.011	0.020
Holiday	0	0.010	0.016	0.028	0.015	0.023	0.030	0.010	0.016	0.028	0.010	0.004	0.012	0.015	0.023	0.032	0.013	0.023	0.032	0.024	0.008	0.016
Holiday	1	0.006	0.013	0.027	0.009	0.018	0.027	0.006	0.013	0.027	0.006	0.004	0.011	0.010	0.018	0.030	0.008	0.019	0.030	0.022	0.009	0.015
Holiday	2	0.004	0.012	0.026	0.007	0.015	0.025	0.004	0.012	0.026	0.004	0.003	0.012	0.008	0.018	0.029	0.006	0.018	0.030	0.024	0.007	0.015
Holiday	3	0.005	0.013	0.027	0.006	0.015	0.025	0.005	0.013	0.027	0.004	0.005	0.015	0.009	0.020	0.031	0.006	0.019	0.030	0.024	0.009	0.017
Holiday	4	0.008	0.016	0.029	0.010	0.019	0.029	0.008	0.016	0.029	0.007	0.009	0.024	0.016	0.027	0.035	0.010	0.023	0.033	0.031	0.019	0.019
Holiday	5	0.014	0.023	0.032	0.023	0.032	0.038	0.014	0.023	0.032	0.014	0.020	0.037	0.026	0.036	0.041	0.019	0.032	0.037	0.033	0.029	0.024
Holiday	6	0.025	0.033	0.036	0.038	0.047	0.047	0.025	0.033	0.036	0.030	0.036	0.047	0.035	0.044	0.044	0.031	0.041	0.043	0.038	0.042	0.030
Holiday	7	0.036	0.044	0.042	0.047	0.057	0.053	0.036	0.044	0.042	0.044	0.052	0.061	0.041	0.049	0.046	0.042	0.049	0.046	0.040	0.044	0.037
Holiday	8	0.046	0.053	0.048	0.047	0.058	0.053	0.046	0.053	0.048	0.052	0.066	0.075	0.046	0.054	0.049	0.048	0.054	0.049	0.037	0.050	0.041
Holiday	9	0.054	0.059	0.050	0.050	0.060	0.054	0.054	0.059	0.050	0.053	0.071	0.081	0.051	0.057	0.050	0.052	0.057	0.051	0.046	0.057	0.048
Holiday	10	0.065	0.069	0.053	0.055	0.064	0.056	0.065	0.069	0.053	0.059	0.076	0.081	0.056	0.061	0.051	0.057	0.060	0.052	0.048	0.066	0.056
Holiday	11	0.074	0.074	0.057	0.059	0.067	0.058	0.074	0.074	0.057	0.066	0.076	0.071	0.061	0.065	0.053	0.063	0.065	0.054	0.055	0.077	0.063
Holiday	12	0.077	0.074	0.056	0.061	0.068	0.057	0.077	0.074	0.056	0.071	0.078	0.074	0.063	0.066	0.053	0.067	0.065	0.054	0.052	0.074	0.065
Holiday	13	0.076	0.074	0.058	0.062	0.067	0.057	0.076	0.074	0.058	0.071	0.076	0.065	0.064	0.066	0.053	0.068	0.066	0.055	0.055	0.071	0.069
Holiday	14	0.075	0.073	0.056	0.064	0.066	0.055	0.075	0.073	0.056	0.070	0.078	0.060	0.064	0.064	0.052	0.069	0.065	0.053	0.050	0.071	0.067
Holiday	15	0.074	0.070	0.055	0.065	0.062	0.052	0.074	0.070	0.055	0.075	0.075	0.053	0.064	0.061	0.050	0.070	0.063	0.052	0.061	0.068	0.068
Holiday	16	0.072	0.066	0.054	0.064	0.057	0.049	0.072	0.066	0.054	0.079	0.070	0.044	0.064	0.058	0.048	0.069	0.060	0.049	0.062	0.069	0.058
Holiday	17	0.068	0.059	0.051	0.064	0.051	0.045	0.068	0.059	0.051	0.074	0.064	0.041	0.064	0.053	0.045	0.066	0.054	0.046	0.058	0.062	0.058
Holiday	18	0.057	0.049	0.045	0.058	0.042	0.040	0.057	0.049	0.045	0.058	0.044	0.034	0.059	0.046	0.043	0.058	0.046	0.042	0.054	0.050	0.049
Holiday	19	0.047	0.036	0.041	0.052	0.032	0.034	0.047	0.036	0.041	0.047	0.033	0.026	0.052	0.036	0.038	0.049	0.036	0.037	0.049	0.037	0.047
Holiday	20	0.039	0.029	0.037	0.046	0.025	0.030	0.039	0.029	0.037	0.038	0.025	0.025	0.045	0.029	0.036	0.043	0.030	0.034	0.046	0.032	0.043
Holiday	21	0.030	0.020	0.033	0.041	0.021	0.029	0.030	0.020	0.033	0.030	0.018	0.021	0.039	0.022	0.032	0.037	0.024	0.031	0.040	0.025	0.038
Holiday	22	0.023	0.015	0.031	0.035	0.018	0.029	0.023	0.015	0.031	0.024	0.011	0.017	0.029	0.016	0.030	0.029	0.019	0.029	0.031	0.016	0.032
Holiday	23	0.015	0.010	0.029	0.023	0.014	0.030	0.015	0.010	0.029	0.014	0.007	0.014	0.021	0.011	0.028	0.020	0.014	0.029	0.020	0.008	0.028

		San Bernardino			San Diego			San Francisco			San Joaquin			San Luis Obispo			San Mateo			Santa Barbara		
Day of Week	**Hour**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**
Sunday	0	0.024	0.030	0.035	0.019	0.033	0.051	0.026	0.032	0.056	0.016	0.024	0.039	0.017	0.009	0.017	0.021	0.029	0.049	0.020	0.017	0.032
Sunday	1	0.017	0.025	0.031	0.012	0.029	0.044	0.019	0.030	0.050	0.010	0.017	0.034	0.017	0.006	0.012	0.013	0.029	0.047	0.021	0.015	0.026
Sunday	2	0.014	0.022	0.028	0.009	0.026	0.040	0.017	0.030	0.048	0.007	0.015	0.031	0.018	0.005	0.009	0.010	0.028	0.045	0.020	0.012	0.022
Sunday	3	0.011	0.020	0.027	0.007	0.023	0.036	0.011	0.028	0.042	0.006	0.014	0.030	0.018	0.004	0.011	0.006	0.029	0.043	0.019	0.010	0.022
Sunday	4	0.012	0.020	0.027	0.007	0.023	0.034	0.009	0.028	0.040	0.008	0.015	0.030	0.019	0.005	0.009	0.007	0.029	0.041	0.023	0.014	0.023
Sunday	5	0.015	0.022	0.028	0.011	0.026	0.035	0.011	0.029	0.039	0.011	0.018	0.031	0.022	0.009	0.012	0.010	0.030	0.040	0.023	0.017	0.029
Sunday	6	0.021	0.026	0.030	0.018	0.030	0.037	0.018	0.032	0.040	0.017	0.022	0.033	0.026	0.015	0.017	0.015	0.031	0.039	0.029	0.024	0.031
Sunday	7	0.027	0.031	0.033	0.026	0.035	0.040	0.024	0.032	0.039	0.023	0.027	0.036	0.030	0.024	0.025	0.022	0.033	0.038	0.031	0.029	0.031
Sunday	8	0.036	0.038	0.037	0.037	0.041	0.043	0.033	0.036	0.040	0.032	0.036	0.040	0.037	0.037	0.039	0.032	0.036	0.038	0.036	0.042	0.037
Sunday	9	0.046	0.046	0.041	0.050	0.048	0.047	0.047	0.042	0.043	0.045	0.048	0.046	0.043	0.056	0.050	0.047	0.040	0.039	0.042	0.054	0.047
Sunday	10	0.055	0.055	0.047	0.062	0.055	0.050	0.060	0.049	0.044	0.056	0.059	0.050	0.051	0.072	0.068	0.062	0.046	0.042	0.046	0.065	0.055
Sunday	11	0.060	0.060	0.050	0.068	0.059	0.050	0.065	0.053	0.045	0.063	0.067	0.054	0.054	0.079	0.080	0.069	0.052	0.042	0.049	0.072	0.059
Sunday	12	0.064	0.066	0.053	0.072	0.061	0.051	0.067	0.056	0.043	0.068	0.071	0.056	0.058	0.089	0.088	0.072	0.056	0.043	0.055	0.078	0.062
Sunday	13	0.067	0.067	0.054	0.072	0.062	0.049	0.067	0.056	0.041	0.071	0.074	0.055	0.059	0.085	0.081	0.073	0.057	0.042	0.057	0.074	0.057
Sunday	14	0.068	0.066	0.054	0.071	0.059	0.046	0.067	0.056	0.040	0.073	0.073	0.054	0.062	0.085	0.075	0.072	0.058	0.041	0.060	0.072	0.051
Sunday	15	0.066	0.063	0.053	0.071	0.057	0.043	0.066	0.056	0.039	0.073	0.071	0.053	0.065	0.081	0.066	0.070	0.059	0.041	0.061	0.070	0.051
Sunday	16	0.065	0.060	0.052	0.070	0.056	0.042	0.065	0.057	0.038	0.073	0.068	0.050	0.067	0.076	0.063	0.070	0.060	0.041	0.063	0.066	0.049
Sunday	17	0.063	0.056	0.051	0.067	0.053	0.040	0.063	0.057	0.038	0.072	0.063	0.049	0.065	0.070	0.064	0.068	0.060	0.043	0.064	0.059	0.049
Sunday	18	0.060	0.051	0.049	0.061	0.048	0.038	0.058	0.054	0.038	0.067	0.055	0.044	0.063	0.058	0.055	0.059	0.055	0.041	0.061	0.054	0.046
Sunday	19	0.056	0.045	0.047	0.054	0.043	0.036	0.053	0.048	0.037	0.061	0.047	0.041	0.057	0.046	0.044	0.052	0.049	0.040	0.059	0.046	0.043
Sunday	20	0.052	0.042	0.047	0.047	0.039	0.036	0.049	0.044	0.038	0.054	0.040	0.039	0.053	0.037	0.035	0.049	0.045	0.041	0.053	0.040	0.043
Sunday	21	0.044	0.036	0.045	0.039	0.035	0.036	0.045	0.038	0.039	0.044	0.031	0.036	0.045	0.026	0.032	0.045	0.039	0.041	0.045	0.031	0.046
Sunday	22	0.034	0.030	0.042	0.029	0.030	0.037	0.037	0.032	0.041	0.031	0.024	0.035	0.034	0.016	0.025	0.034	0.030	0.040	0.035	0.023	0.045
Sunday	23	0.023	0.025	0.041	0.019	0.027	0.040	0.025	0.025	0.044	0.019	0.019	0.036	0.023	0.010	0.024	0.021	0.022	0.040	0.026	0.017	0.042
Monday	0	0.015	0.017	0.023	0.009	0.018	0.023	0.012	0.020	0.031	0.010	0.012	0.022	0.018	0.004	0.008	0.009	0.016	0.025	0.016	0.005	0.012
Monday	1	0.011	0.015	0.022	0.005	0.017	0.022	0.007	0.021	0.030	0.006	0.010	0.021	0.017	0.003	0.008	0.004	0.018	0.026	0.015	0.004	0.014
Monday	2	0.010	0.015	0.022	0.004	0.017	0.023	0.005	0.021	0.031	0.006	0.010	0.022	0.018	0.003	0.010	0.003	0.019	0.028	0.016	0.005	0.016
Monday	3	0.014	0.018	0.024	0.005	0.018	0.024	0.005	0.022	0.031	0.011	0.015	0.025	0.020	0.006	0.014	0.003	0.020	0.029	0.018	0.007	0.019
Monday	4	0.025	0.028	0.029	0.012	0.022	0.028	0.010	0.025	0.035	0.029	0.028	0.033	0.024	0.011	0.019	0.007	0.022	0.031	0.020	0.013	0.028
Monday	5	0.041	0.044	0.038	0.031	0.034	0.037	0.023	0.031	0.040	0.043	0.043	0.042	0.031	0.027	0.029	0.020	0.026	0.034	0.028	0.025	0.038
Monday	6	0.052	0.053	0.044	0.055	0.050	0.047	0.045	0.040	0.046	0.053	0.052	0.048	0.040	0.048	0.041	0.044	0.035	0.041	0.037	0.048	0.045
Monday	7	0.061	0.065	0.052	0.068	0.066	0.057	0.064	0.057	0.055	0.061	0.059	0.053	0.046	0.065	0.053	0.071	0.058	0.057	0.048	0.071	0.046
Monday	8	0.056	0.056	0.047	0.063	0.062	0.058	0.064	0.064	0.057	0.055	0.057	0.053	0.049	0.066	0.057	0.071	0.070	0.064	0.054	0.083	0.052
Monday	9	0.051	0.051	0.045	0.055	0.056	0.054	0.059	0.054	0.054	0.051	0.056	0.055	0.051	0.069	0.064	0.065	0.059	0.058	0.054	0.078	0.055
Monday	10	0.050	0.050	0.045	0.051	0.055	0.054	0.055	0.053	0.054	0.051	0.058	0.056	0.051	0.070	0.073	0.057	0.052	0.053	0.053	0.069	0.060
Monday	11	0.052	0.052	0.046	0.052	0.056	0.055	0.053	0.053	0.055	0.052	0.060	0.058	0.054	0.070	0.074	0.052	0.050	0.051	0.056	0.072	0.066
Monday	12	0.054	0.054	0.049	0.054	0.058	0.057	0.053	0.054	0.053	0.054	0.061	0.058	0.055	0.070	0.070	0.051	0.053	0.051	0.060	0.073	0.069
Monday	13	0.055	0.057	0.051	0.056	0.059	0.057	0.053	0.056	0.053	0.056	0.063	0.057	0.058	0.071	0.070	0.052	0.055	0.051	0.062	0.072	0.064
Monday	14	0.059	0.062	0.055	0.063	0.062	0.057	0.059	0.059	0.052	0.063	0.068	0.058	0.064	0.076	0.067	0.056	0.059	0.052	0.065	0.075	0.062
Monday	15	0.063	0.065	0.058	0.072	0.065	0.057	0.063	0.061	0.051	0.069	0.072	0.059	0.068	0.083	0.061	0.063	0.065	0.055	0.070	0.077	0.060
Monday	16	0.064	0.066	0.060	0.075	0.065	0.057	0.065	0.061	0.049	0.072	0.071	0.056	0.068	0.079	0.053	0.070	0.070	0.057	0.067	0.067	0.052
Monday	17	0.064	0.065	0.060	0.073	0.062	0.055	0.067	0.068	0.049	0.070	0.065	0.052	0.064	0.065	0.047	0.074	0.077	0.059	0.058	0.046	0.041
Monday	18	0.054	0.050	0.052	0.058	0.046	0.044	0.062	0.056	0.042	0.055	0.045	0.041	0.051	0.041	0.040	0.067	0.059	0.048	0.050	0.034	0.037
Monday	19	0.042	0.035	0.043	0.041	0.033	0.034	0.050	0.039	0.033	0.041	0.031	0.033	0.043	0.026	0.036	0.051	0.039	0.035	0.045	0.025	0.035
Monday	20	0.035	0.028	0.038	0.033	0.026	0.029	0.039	0.030	0.027	0.033	0.023	0.028	0.037	0.018	0.030	0.037	0.029	0.028	0.036	0.017	0.033
Monday	21	0.031	0.023	0.036	0.028	0.022	0.025	0.036	0.024	0.024	0.027	0.017	0.026	0.031	0.014	0.027	0.033	0.022	0.024	0.030	0.013	0.034
Monday	22	0.025	0.018	0.033	0.020	0.017	0.023	0.031	0.018	0.023	0.021	0.013	0.023	0.024	0.009	0.026	0.025	0.016	0.022	0.024	0.010	0.032
Monday	23	0.018	0.013	0.030	0.013	0.015	0.022	0.021	0.013	0.025	0.014	0.010	0.022	0.017	0.005	0.021	0.015	0.011	0.020	0.016	0.007	0.030
Tues/Wed/Thurs	0	0.013	0.016	0.024	0.007	0.017	0.025	0.012	0.019	0.032	0.009	0.011	0.024	0.016	0.004	0.017	0.008	0.016	0.026	0.016	0.005	0.022
Tues/Wed/Thurs	1	0.010	0.014	0.023	0.004	0.016	0.024	0.007	0.019	0.031	0.006	0.010	0.023	0.016	0.003	0.014	0.003	0.017	0.027	0.015	0.004	0.022
Tues/Wed/Thurs	2	0.010	0.015	0.024	0.003	0.016	0.024	0.005	0.020	0.032	0.005	0.010	0.023	0.016	0.003	0.014	0.002	0.018	0.028	0.015	0.004	0.021
Tues/Wed/Thurs	3	0.013	0.018	0.025	0.004	0.017	0.026	0.005	0.021	0.032	0.010	0.014	0.026	0.018	0.004	0.017	0.003	0.019	0.029	0.017	0.006	0.024

		San Bernardino			San Diego			San Francisco			San Joaquin			San Luis Obispo			San Mateo			Santa Barbara		
Day of Week	**Hour**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**
Tues/Wed/Thurs	4	0.024	0.027	0.031	0.010	0.022	0.029	0.009	0.024	0.036	0.027	0.026	0.034	0.021	0.009	0.022	0.007	0.021	0.031	0.019	0.012	0.033
Tues/Wed/Thurs	5	0.041	0.044	0.040	0.029	0.033	0.038	0.024	0.029	0.041	0.043	0.041	0.042	0.030	0.023	0.032	0.020	0.025	0.034	0.026	0.025	0.045
Tues/Wed/Thurs	6	0.053	0.053	0.046	0.055	0.050	0.049	0.047	0.040	0.049	0.054	0.051	0.049	0.041	0.049	0.046	0.046	0.035	0.042	0.039	0.051	0.052
Tues/Wed/Thurs	7	0.062	0.065	0.054	0.068	0.067	0.059	0.065	0.058	0.057	0.062	0.059	0.054	0.048	0.066	0.057	0.073	0.059	0.058	0.051	0.072	0.052
Tues/Wed/Thurs	8	0.056	0.057	0.050	0.063	0.064	0.059	0.064	0.067	0.059	0.056	0.057	0.054	0.049	0.067	0.060	0.071	0.072	0.066	0.056	0.083	0.056
Tues/Wed/Thurs	9	0.050	0.051	0.046	0.055	0.056	0.055	0.058	0.054	0.055	0.051	0.055	0.055	0.050	0.066	0.065	0.064	0.058	0.058	0.056	0.079	0.057
Tues/Wed/Thurs	10	0.049	0.049	0.046	0.050	0.054	0.054	0.053	0.051	0.053	0.049	0.056	0.056	0.052	0.066	0.067	0.054	0.050	0.052	0.054	0.070	0.060
Tues/Wed/Thurs	11	0.050	0.051	0.047	0.051	0.056	0.055	0.051	0.052	0.054	0.050	0.058	0.056	0.053	0.067	0.071	0.050	0.049	0.050	0.057	0.072	0.064
Tues/Wed/Thurs	12	0.052	0.053	0.049	0.053	0.058	0.056	0.051	0.053	0.053	0.052	0.059	0.056	0.056	0.069	0.067	0.049	0.051	0.050	0.060	0.071	0.062
Tues/Wed/Thurs	13	0.054	0.056	0.051	0.055	0.059	0.055	0.052	0.055	0.052	0.055	0.062	0.056	0.060	0.071	0.065	0.050	0.054	0.051	0.063	0.072	0.060
Tues/Wed/Thurs	14	0.058	0.062	0.054	0.063	0.062	0.056	0.058	0.059	0.051	0.062	0.068	0.057	0.063	0.076	0.064	0.056	0.058	0.052	0.064	0.075	0.058
Tues/Wed/Thurs	15	0.062	0.065	0.057	0.072	0.065	0.055	0.060	0.061	0.050	0.069	0.074	0.058	0.069	0.084	0.058	0.062	0.065	0.054	0.067	0.076	0.052
Tues/Wed/Thurs	16	0.064	0.067	0.059	0.074	0.065	0.055	0.064	0.062	0.047	0.072	0.074	0.057	0.070	0.081	0.050	0.070	0.071	0.056	0.064	0.065	0.044
Tues/Wed/Thurs	17	0.064	0.066	0.058	0.073	0.063	0.054	0.065	0.070	0.047	0.070	0.067	0.053	0.063	0.067	0.045	0.072	0.081	0.061	0.056	0.045	0.036
Tues/Wed/Thurs	18	0.055	0.052	0.050	0.061	0.047	0.043	0.062	0.059	0.041	0.056	0.048	0.041	0.053	0.044	0.039	0.067	0.065	0.051	0.050	0.036	0.034
Tues/Wed/Thurs	19	0.044	0.037	0.041	0.044	0.033	0.033	0.052	0.041	0.032	0.043	0.033	0.033	0.044	0.029	0.034	0.053	0.041	0.036	0.044	0.026	0.031
Tues/Wed/Thurs	20	0.038	0.029	0.037	0.036	0.026	0.028	0.042	0.031	0.026	0.034	0.025	0.028	0.038	0.021	0.028	0.039	0.029	0.027	0.037	0.019	0.029
Tues/Wed/Thurs	21	0.033	0.023	0.033	0.031	0.021	0.025	0.039	0.024	0.024	0.028	0.019	0.025	0.032	0.016	0.026	0.035	0.022	0.023	0.031	0.015	0.031
Tues/Wed/Thurs	22	0.027	0.017	0.029	0.022	0.017	0.022	0.034	0.018	0.023	0.021	0.014	0.022	0.025	0.010	0.023	0.027	0.015	0.019	0.025	0.011	0.027
Tues/Wed/Thurs	23	0.020	0.012	0.025	0.014	0.014	0.021	0.023	0.012	0.024	0.015	0.010	0.021	0.018	0.006	0.019	0.017	0.010	0.017	0.018	0.008	0.026
Friday	0	0.014	0.016	0.025	0.008	0.018	0.027	0.014	0.020	0.034	0.008	0.012	0.025	0.016	0.004	0.016	0.009	0.016	0.027	0.016	0.006	0.024
Friday	1	0.011	0.014	0.024	0.005	0.017	0.026	0.008	0.020	0.033	0.006	0.010	0.024	0.016	0.003	0.014	0.005	0.017	0.029	0.016	0.005	0.022
Friday	2	0.010	0.014	0.024	0.004	0.017	0.027	0.007	0.020	0.033	0.005	0.010	0.024	0.016	0.003	0.014	0.003	0.018	0.029	0.016	0.005	0.021
Friday	3	0.013	0.017	0.026	0.005	0.018	0.028	0.006	0.022	0.034	0.009	0.013	0.027	0.017	0.004	0.017	0.003	0.020	0.031	0.016	0.006	0.025
Friday	4	0.021	0.024	0.030	0.009	0.021	0.031	0.009	0.024	0.036	0.022	0.023	0.034	0.020	0.007	0.022	0.007	0.021	0.032	0.020	0.011	0.033
Friday	5	0.035	0.037	0.038	0.026	0.032	0.040	0.022	0.029	0.042	0.036	0.036	0.042	0.027	0.018	0.031	0.019	0.025	0.035	0.025	0.022	0.043
Friday	6	0.046	0.046	0.044	0.048	0.047	0.050	0.043	0.039	0.048	0.046	0.045	0.048	0.038	0.042	0.045	0.042	0.034	0.042	0.038	0.046	0.050
Friday	7	0.055	0.056	0.050	0.061	0.060	0.058	0.060	0.053	0.056	0.053	0.052	0.053	0.044	0.058	0.054	0.067	0.053	0.056	0.046	0.068	0.051
Friday	8	0.052	0.052	0.048	0.057	0.058	0.058	0.060	0.059	0.058	0.049	0.051	0.054	0.048	0.061	0.059	0.068	0.060	0.061	0.053	0.079	0.056
Friday	9	0.049	0.048	0.046	0.052	0.055	0.056	0.055	0.052	0.056	0.046	0.052	0.055	0.049	0.064	0.065	0.061	0.054	0.056	0.054	0.079	0.062
Friday	10	0.050	0.050	0.047	0.051	0.055	0.056	0.052	0.052	0.056	0.048	0.055	0.057	0.052	0.068	0.070	0.054	0.050	0.052	0.053	0.071	0.063
Friday	11	0.052	0.053	0.050	0.054	0.058	0.058	0.052	0.055	0.056	0.050	0.058	0.059	0.054	0.070	0.072	0.053	0.051	0.052	0.058	0.074	0.066
Friday	12	0.054	0.055	0.051	0.056	0.060	0.058	0.053	0.055	0.054	0.054	0.061	0.058	0.056	0.072	0.070	0.052	0.054	0.052	0.059	0.073	0.061
Friday	13	0.056	0.058	0.053	0.059	0.061	0.057	0.054	0.057	0.053	0.058	0.065	0.058	0.060	0.074	0.068	0.053	0.057	0.053	0.064	0.073	0.058
Friday	14	0.059	0.063	0.056	0.066	0.063	0.056	0.058	0.060	0.052	0.065	0.070	0.059	0.064	0.079	0.066	0.059	0.062	0.055	0.066	0.073	0.056
Friday	15	0.060	0.066	0.058	0.071	0.065	0.055	0.060	0.063	0.050	0.069	0.075	0.059	0.067	0.083	0.058	0.064	0.070	0.057	0.067	0.074	0.052
Friday	16	0.061	0.066	0.058	0.070	0.064	0.054	0.062	0.064	0.047	0.071	0.073	0.057	0.068	0.078	0.051	0.069	0.073	0.058	0.064	0.062	0.045
Friday	17	0.060	0.064	0.056	0.068	0.060	0.050	0.062	0.067	0.046	0.069	0.069	0.053	0.062	0.064	0.047	0.069	0.079	0.059	0.057	0.046	0.038
Friday	18	0.055	0.053	0.050	0.060	0.048	0.041	0.059	0.056	0.039	0.061	0.052	0.041	0.056	0.048	0.039	0.064	0.063	0.049	0.050	0.036	0.035
Friday	19	0.048	0.043	0.043	0.048	0.035	0.031	0.052	0.043	0.031	0.050	0.038	0.031	0.047	0.033	0.032	0.052	0.043	0.035	0.046	0.028	0.031
Friday	20	0.043	0.035	0.038	0.039	0.027	0.025	0.042	0.032	0.025	0.042	0.029	0.026	0.042	0.025	0.028	0.039	0.031	0.026	0.038	0.022	0.029
Friday	21	0.039	0.029	0.034	0.035	0.023	0.021	0.039	0.025	0.021	0.035	0.022	0.022	0.036	0.019	0.024	0.034	0.023	0.021	0.032	0.017	0.029
Friday	22	0.033	0.022	0.029	0.029	0.020	0.019	0.039	0.020	0.020	0.028	0.017	0.019	0.028	0.014	0.021	0.031	0.017	0.017	0.027	0.014	0.026
Friday	23	0.025	0.016	0.024	0.020	0.016	0.017	0.031	0.014	0.020	0.020	0.012	0.017	0.021	0.009	0.017	0.023	0.011	0.014	0.019	0.010	0.024
Saturday	0	0.020	0.024	0.034	0.015	0.026	0.043	0.022	0.026	0.048	0.014	0.021	0.037	0.018	0.007	0.027	0.017	0.024	0.042	0.022	0.013	0.039
Saturday	1	0.015	0.020	0.031	0.010	0.023	0.039	0.015	0.025	0.045	0.009	0.016	0.032	0.020	0.006	0.022	0.010	0.024	0.041	0.021	0.010	0.032
Saturday	2	0.013	0.019	0.029	0.007	0.022	0.037	0.013	0.025	0.043	0.007	0.014	0.031	0.020	0.005	0.020	0.008	0.024	0.041	0.022	0.009	0.030
Saturday	3	0.013	0.018	0.029	0.006	0.020	0.035	0.009	0.025	0.041	0.007	0.015	0.031	0.021	0.005	0.021	0.006	0.025	0.041	0.022	0.010	0.032
Saturday	4	0.015	0.020	0.030	0.007	0.022	0.036	0.008	0.026	0.039	0.011	0.018	0.033	0.022	0.007	0.023	0.007	0.026	0.041	0.024	0.014	0.040
Saturday	5	0.021	0.025	0.033	0.014	0.026	0.039	0.013	0.028	0.041	0.018	0.025	0.037	0.025	0.013	0.031	0.011	0.028	0.042	0.028	0.021	0.046
Saturday	6	0.030	0.032	0.038	0.024	0.032	0.045	0.021	0.031	0.044	0.027	0.033	0.042	0.032	0.024	0.039	0.019	0.031	0.043	0.035	0.035	0.053
Saturday	7	0.039	0.040	0.043	0.036	0.040	0.051	0.031	0.036	0.047	0.036	0.042	0.048	0.038	0.041	0.051	0.031	0.035	0.044	0.040	0.048	0.054

		San Bernardino			San Diego			San Francisco			San Joaquin			San Luis Obispo			San Mateo			Santa Barbara		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Saturday	8	0.046	0.047	0.048	0.048	0.048	0.056	0.043	0.041	0.051	0.045	0.050	0.054	0.047	0.053	0.055	0.043	0.039	0.046	0.046	0.059	0.057
Saturday	9	0.052	0.052	0.050	0.056	0.054	0.059	0.052	0.046	0.052	0.054	0.059	0.058	0.050	0.067	0.062	0.054	0.045	0.048	0.050	0.068	0.060
Saturday	10	0.056	0.056	0.053	0.062	0.058	0.060	0.059	0.051	0.053	0.061	0.067	0.062	0.054	0.078	0.069	0.062	0.050	0.051	0.053	0.070	0.059
Saturday	11	0.059	0.060	0.055	0.066	0.061	0.060	0.062	0.055	0.052	0.065	0.071	0.063	0.059	0.084	0.078	0.067	0.056	0.053	0.057	0.073	0.059
Saturday	12	0.061	0.063	0.057	0.068	0.063	0.058	0.063	0.057	0.051	0.067	0.072	0.062	0.060	0.082	0.070	0.068	0.059	0.051	0.059	0.074	0.056
Saturday	13	0.062	0.063	0.055	0.068	0.062	0.055	0.062	0.058	0.048	0.067	0.070	0.059	0.061	0.079	0.064	0.067	0.060	0.050	0.061	0.070	0.051
Saturday	14	0.062	0.063	0.055	0.068	0.061	0.051	0.062	0.059	0.046	0.067	0.068	0.056	0.060	0.074	0.061	0.067	0.061	0.049	0.061	0.068	0.048
Saturday	15	0.062	0.062	0.054	0.068	0.059	0.047	0.063	0.059	0.043	0.067	0.065	0.052	0.062	0.072	0.053	0.067	0.062	0.048	0.061	0.061	0.045
Saturday	16	0.061	0.060	0.052	0.067	0.057	0.043	0.063	0.059	0.042	0.066	0.061	0.048	0.061	0.066	0.050	0.067	0.062	0.046	0.059	0.059	0.041
Saturday	17	0.059	0.057	0.049	0.064	0.054	0.039	0.061	0.059	0.039	0.063	0.055	0.043	0.059	0.059	0.044	0.067	0.061	0.044	0.057	0.053	0.036
Saturday	18	0.055	0.051	0.044	0.057	0.047	0.033	0.058	0.056	0.036	0.057	0.045	0.036	0.053	0.050	0.037	0.061	0.055	0.040	0.052	0.046	0.033
Saturday	19	0.048	0.042	0.039	0.048	0.040	0.027	0.051	0.047	0.031	0.049	0.036	0.030	0.048	0.038	0.031	0.049	0.046	0.034	0.045	0.036	0.029
Saturday	20	0.043	0.037	0.035	0.042	0.035	0.023	0.044	0.040	0.028	0.043	0.030	0.026	0.043	0.032	0.029	0.042	0.039	0.030	0.041	0.031	0.029
Saturday	21	0.041	0.034	0.033	0.039	0.033	0.022	0.044	0.034	0.026	0.040	0.026	0.023	0.037	0.027	0.025	0.042	0.035	0.028	0.035	0.027	0.024
Saturday	22	0.037	0.029	0.030	0.034	0.031	0.021	0.045	0.032	0.027	0.035	0.023	0.021	0.028	0.018	0.021	0.040	0.030	0.025	0.029	0.023	0.023
Saturday	23	0.030	0.023	0.026	0.025	0.027	0.020	0.036	0.025	0.026	0.025	0.017	0.019	0.021	0.013	0.017	0.029	0.022	0.022	0.023	0.019	0.021
Holiday	0	0.018	0.020	0.026	0.013	0.023	0.029	0.021	0.023	0.035	0.012	0.015	0.027	0.018	0.006	0.012	0.014	0.020	0.030	0.020	0.010	0.020
Holiday	1	0.014	0.018	0.024	0.008	0.021	0.027	0.013	0.022	0.033	0.008	0.013	0.025	0.019	0.004	0.009	0.008	0.021	0.031	0.021	0.008	0.020
Holiday	2	0.012	0.017	0.024	0.006	0.020	0.027	0.010	0.024	0.033	0.006	0.012	0.025	0.019	0.003	0.011	0.005	0.022	0.031	0.019	0.006	0.018
Holiday	3	0.013	0.018	0.026	0.005	0.020	0.027	0.007	0.025	0.033	0.008	0.014	0.026	0.022	0.005	0.013	0.004	0.024	0.033	0.021	0.008	0.023
Holiday	4	0.019	0.024	0.029	0.008	0.023	0.030	0.008	0.028	0.035	0.015	0.020	0.030	0.022	0.008	0.015	0.006	0.025	0.034	0.022	0.012	0.028
Holiday	5	0.029	0.032	0.034	0.019	0.029	0.034	0.016	0.031	0.039	0.023	0.028	0.035	0.028	0.017	0.021	0.014	0.029	0.037	0.027	0.023	0.037
Holiday	6	0.036	0.038	0.037	0.035	0.040	0.042	0.028	0.036	0.044	0.031	0.035	0.039	0.034	0.030	0.031	0.027	0.035	0.041	0.031	0.034	0.042
Holiday	7	0.043	0.045	0.041	0.046	0.048	0.049	0.039	0.042	0.047	0.036	0.040	0.043	0.041	0.044	0.040	0.044	0.043	0.046	0.042	0.060	0.045
Holiday	8	0.047	0.048	0.043	0.048	0.050	0.050	0.046	0.049	0.050	0.041	0.045	0.047	0.046	0.055	0.046	0.053	0.048	0.050	0.048	0.073	0.051
Holiday	9	0.049	0.050	0.045	0.052	0.053	0.053	0.051	0.049	0.053	0.047	0.051	0.050	0.050	0.065	0.062	0.055	0.050	0.050	0.051	0.075	0.059
Holiday	10	0.053	0.053	0.047	0.057	0.058	0.056	0.057	0.054	0.054	0.055	0.061	0.056	0.052	0.076	0.072	0.058	0.052	0.052	0.053	0.071	0.058
Holiday	11	0.057	0.059	0.052	0.062	0.063	0.059	0.061	0.057	0.056	0.063	0.069	0.061	0.052	0.082	0.088	0.062	0.056	0.053	0.057	0.076	0.066
Holiday	12	0.060	0.063	0.053	0.065	0.065	0.060	0.063	0.059	0.055	0.066	0.072	0.062	0.058	0.086	0.085	0.062	0.060	0.055	0.059	0.079	0.070
Holiday	13	0.062	0.064	0.055	0.066	0.066	0.059	0.065	0.062	0.057	0.068	0.074	0.062	0.061	0.081	0.082	0.065	0.062	0.055	0.061	0.072	0.056
Holiday	14	0.063	0.066	0.056	0.068	0.065	0.058	0.067	0.063	0.055	0.070	0.073	0.060	0.059	0.076	0.075	0.067	0.066	0.056	0.060	0.073	0.060
Holiday	15	0.062	0.066	0.057	0.070	0.064	0.057	0.065	0.064	0.053	0.071	0.072	0.058	0.064	0.077	0.065	0.068	0.067	0.054	0.064	0.072	0.055
Holiday	16	0.062	0.063	0.057	0.069	0.060	0.053	0.063	0.062	0.048	0.071	0.068	0.054	0.068	0.072	0.057	0.069	0.067	0.055	0.060	0.061	0.050
Holiday	17	0.062	0.061	0.056	0.066	0.055	0.048	0.061	0.058	0.045	0.068	0.061	0.050	0.062	0.063	0.046	0.069	0.063	0.051	0.059	0.047	0.037
Holiday	18	0.056	0.053	0.052	0.058	0.045	0.042	0.057	0.052	0.040	0.060	0.050	0.042	0.053	0.044	0.039	0.060	0.053	0.044	0.053	0.038	0.036
Holiday	19	0.048	0.043	0.046	0.049	0.037	0.035	0.049	0.042	0.032	0.051	0.040	0.037	0.047	0.035	0.037	0.050	0.044	0.037	0.049	0.029	0.036
Holiday	20	0.043	0.034	0.041	0.043	0.030	0.030	0.044	0.034	0.029	0.044	0.031	0.032	0.041	0.027	0.028	0.045	0.033	0.032	0.040	0.024	0.032
Holiday	21	0.037	0.027	0.037	0.037	0.025	0.027	0.042	0.028	0.024	0.037	0.025	0.029	0.035	0.019	0.023	0.042	0.027	0.028	0.036	0.020	0.038
Holiday	22	0.031	0.021	0.033	0.030	0.022	0.025	0.040	0.021	0.025	0.029	0.019	0.026	0.027	0.014	0.022	0.033	0.020	0.025	0.028	0.017	0.034
Holiday	23	0.023	0.015	0.030	0.020	0.018	0.024	0.028	0.016	0.026	0.020	0.013	0.024	0.021	0.010	0.020	0.023	0.014	0.022	0.021	0.013	0.031

		Santa Clara			Santa Cruz			Shasta			Sierra			Siskiyou			Solano			Sonoma		
Day of Week	**Hour**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**
Sunday	0	0.018	0.036	0.052	0.011	0.032	0.036	0.013	0.008	0.016	0.013	0.020	0.031	0.019	0.009	0.017	0.017	0.037	0.059	0.019	0.038	0.053
Sunday	1	0.011	0.034	0.046	0.006	0.031	0.036	0.013	0.006	0.013	0.008	0.016	0.028	0.021	0.007	0.014	0.011	0.032	0.052	0.012	0.034	0.047
Sunday	2	0.008	0.032	0.042	0.003	0.030	0.037	0.012	0.006	0.011	0.006	0.013	0.026	0.022	0.006	0.013	0.009	0.030	0.048	0.008	0.031	0.043
Sunday	3	0.005	0.032	0.039	0.002	0.034	0.035	0.012	0.005	0.011	0.005	0.012	0.025	0.022	0.005	0.013	0.007	0.027	0.044	0.006	0.030	0.040
Sunday	4	0.005	0.032	0.037	0.003	0.035	0.038	0.015	0.007	0.013	0.005	0.012	0.025	0.023	0.006	0.013	0.007	0.028	0.042	0.006	0.029	0.038
Sunday	5	0.008	0.033	0.036	0.006	0.035	0.035	0.018	0.012	0.018	0.008	0.015	0.027	0.025	0.008	0.016	0.010	0.029	0.042	0.010	0.031	0.038
Sunday	6	0.014	0.035	0.037	0.013	0.036	0.036	0.021	0.019	0.026	0.013	0.020	0.030	0.028	0.014	0.024	0.016	0.032	0.042	0.016	0.033	0.039
Sunday	7	0.021	0.037	0.039	0.022	0.038	0.039	0.029	0.030	0.039	0.022	0.028	0.034	0.030	0.022	0.034	0.021	0.035	0.043	0.023	0.036	0.040
Sunday	8	0.032	0.040	0.040	0.034	0.036	0.040	0.037	0.043	0.053	0.034	0.041	0.040	0.033	0.036	0.048	0.031	0.041	0.045	0.033	0.040	0.042
Sunday	9	0.047	0.046	0.044	0.051	0.043	0.043	0.043	0.055	0.067	0.048	0.055	0.046	0.036	0.052	0.062	0.046	0.048	0.046	0.048	0.046	0.044
Sunday	10	0.061	0.051	0.047	0.064	0.044	0.047	0.053	0.071	0.079	0.064	0.068	0.052	0.040	0.071	0.075	0.059	0.053	0.045	0.062	0.051	0.045
Sunday	11	0.068	0.053	0.047	0.071	0.047	0.046	0.060	0.077	0.080	0.075	0.075	0.055	0.044	0.082	0.086	0.067	0.055	0.044	0.067	0.053	0.046
Sunday	12	0.073	0.054	0.046	0.073	0.046	0.043	0.064	0.084	0.077	0.082	0.079	0.058	0.049	0.089	0.088	0.069	0.055	0.041	0.070	0.054	0.046
Sunday	13	0.075	0.055	0.045	0.076	0.047	0.041	0.066	0.083	0.070	0.084	0.079	0.058	0.054	0.090	0.080	0.070	0.055	0.038	0.073	0.055	0.050
Sunday	14	0.075	0.055	0.044	0.078	0.052	0.047	0.067	0.085	0.065	0.084	0.077	0.057	0.058	0.089	0.072	0.071	0.053	0.036	0.073	0.055	0.047
Sunday	15	0.075	0.054	0.042	0.081	0.054	0.051	0.072	0.083	0.061	0.082	0.073	0.057	0.063	0.087	0.069	0.071	0.052	0.035	0.073	0.053	0.041
Sunday	16	0.073	0.053	0.041	0.082	0.055	0.051	0.073	0.080	0.058	0.079	0.068	0.055	0.064	0.081	0.059	0.071	0.051	0.033	0.072	0.052	0.039
Sunday	17	0.071	0.051	0.040	0.080	0.058	0.052	0.068	0.066	0.056	0.072	0.062	0.053	0.065	0.066	0.051	0.070	0.051	0.033	0.070	0.050	0.038
Sunday	18	0.064	0.047	0.039	0.069	0.051	0.048	0.065	0.056	0.049	0.060	0.052	0.049	0.065	0.055	0.044	0.066	0.048	0.033	0.063	0.047	0.036
Sunday	19	0.057	0.044	0.038	0.058	0.051	0.047	0.058	0.043	0.041	0.050	0.043	0.045	0.062	0.043	0.036	0.060	0.046	0.034	0.056	0.044	0.035
Sunday	20	0.050	0.040	0.037	0.048	0.047	0.044	0.048	0.031	0.032	0.041	0.035	0.042	0.057	0.032	0.028	0.055	0.043	0.035	0.051	0.041	0.036
Sunday	21	0.041	0.034	0.038	0.036	0.039	0.039	0.041	0.023	0.026	0.031	0.026	0.039	0.049	0.022	0.023	0.045	0.039	0.039	0.042	0.038	0.037
Sunday	22	0.029	0.029	0.040	0.022	0.033	0.036	0.031	0.016	0.021	0.021	0.019	0.036	0.041	0.015	0.019	0.032	0.033	0.043	0.030	0.032	0.039
Sunday	23	0.018	0.024	0.044	0.011	0.028	0.032	0.020	0.012	0.017	0.013	0.015	0.033	0.028	0.012	0.016	0.020	0.028	0.049	0.019	0.027	0.043
Monday	0	0.007	0.022	0.028	0.004	0.024	0.033	0.013	0.006	0.012	0.008	0.014	0.027	0.023	0.007	0.013	0.010	0.026	0.035	0.007	0.023	0.029
Monday	1	0.003	0.022	0.027	0.001	0.025	0.031	0.012	0.006	0.011	0.005	0.012	0.025	0.023	0.006	0.011	0.006	0.025	0.034	0.003	0.022	0.028
Monday	2	0.002	0.023	0.028	0.001	0.025	0.034	0.013	0.006	0.011	0.004	0.012	0.025	0.025	0.007	0.011	0.005	0.024	0.034	0.002	0.022	0.029
Monday	3	0.003	0.025	0.030	0.002	0.025	0.034	0.015	0.010	0.012	0.006	0.014	0.027	0.027	0.010	0.011	0.006	0.026	0.035	0.003	0.023	0.030
Monday	4	0.007	0.029	0.033	0.007	0.031	0.038	0.019	0.019	0.015	0.011	0.019	0.030	0.030	0.015	0.012	0.015	0.032	0.040	0.012	0.028	0.035
Monday	5	0.024	0.035	0.040	0.026	0.034	0.038	0.025	0.030	0.021	0.023	0.030	0.036	0.033	0.022	0.018	0.037	0.043	0.046	0.033	0.041	0.042
Monday	6	0.047	0.046	0.049	0.061	0.043	0.049	0.032	0.041	0.024	0.042	0.047	0.043	0.036	0.034	0.024	0.050	0.051	0.050	0.054	0.051	0.048
Monday	7	0.065	0.054	0.057	0.082	0.053	0.056	0.034	0.048	0.032	0.060	0.061	0.048	0.040	0.043	0.030	0.061	0.058	0.053	0.066	0.058	0.053
Monday	8	0.068	0.057	0.060	0.079	0.054	0.059	0.039	0.059	0.039	0.059	0.062	0.050	0.043	0.054	0.039	0.056	0.057	0.055	0.062	0.060	0.055
Monday	9	0.065	0.055	0.055	0.073	0.053	0.053	0.047	0.065	0.046	0.056	0.061	0.050	0.045	0.067	0.048	0.054	0.056	0.055	0.055	0.056	0.054
Monday	10	0.056	0.053	0.054	0.064	0.050	0.052	0.050	0.070	0.053	0.058	0.064	0.051	0.050	0.074	0.054	0.055	0.058	0.056	0.052	0.054	0.053
Monday	11	0.052	0.054	0.054	0.059	0.055	0.054	0.056	0.072	0.055	0.062	0.066	0.053	0.052	0.075	0.059	0.056	0.057	0.055	0.053	0.055	0.054
Monday	12	0.053	0.055	0.054	0.055	0.060	0.059	0.059	0.073	0.055	0.066	0.068	0.054	0.055	0.078	0.059	0.057	0.058	0.054	0.054	0.056	0.054
Monday	13	0.054	0.056	0.053	0.056	0.054	0.052	0.060	0.076	0.058	0.067	0.067	0.054	0.057	0.081	0.060	0.058	0.057	0.052	0.056	0.056	0.054
Monday	14	0.062	0.060	0.054	0.059	0.061	0.057	0.065	0.079	0.059	0.070	0.069	0.055	0.057	0.081	0.065	0.064	0.057	0.051	0.063	0.059	0.056
Monday	15	0.068	0.063	0.055	0.063	0.060	0.051	0.071	0.081	0.062	0.073	0.069	0.055	0.059	0.080	0.063	0.069	0.056	0.048	0.069	0.063	0.058
Monday	16	0.071	0.063	0.054	0.067	0.059	0.051	0.070	0.070	0.063	0.075	0.067	0.054	0.060	0.072	0.064	0.071	0.054	0.044	0.072	0.060	0.052
Monday	17	0.074	0.062	0.052	0.069	0.058	0.047	0.065	0.057	0.066	0.073	0.061	0.052	0.057	0.059	0.066	0.070	0.050	0.040	0.073	0.056	0.047
Monday	18	0.065	0.050	0.042	0.057	0.051	0.040	0.058	0.042	0.064	0.056	0.046	0.045	0.053	0.045	0.063	0.054	0.041	0.035	0.061	0.045	0.039
Monday	19	0.052	0.037	0.031	0.040	0.042	0.034	0.054	0.031	0.059	0.040	0.031	0.039	0.048	0.032	0.060	0.042	0.032	0.028	0.045	0.033	0.031
Monday	20	0.036	0.028	0.025	0.028	0.030	0.025	0.050	0.022	0.054	0.031	0.022	0.035	0.042	0.022	0.054	0.035	0.026	0.025	0.035	0.026	0.026
Monday	21	0.030	0.022	0.022	0.023	0.024	0.020	0.041	0.017	0.051	0.025	0.017	0.032	0.036	0.016	0.046	0.029	0.022	0.023	0.031	0.022	0.024
Monday	22	0.022	0.016	0.020	0.015	0.018	0.017	0.030	0.011	0.043	0.017	0.012	0.030	0.029	0.012	0.039	0.023	0.018	0.024	0.023	0.017	0.023
Monday	23	0.014	0.012	0.022	0.009	0.013	0.017	0.022	0.008	0.034	0.012	0.009	0.030	0.020	0.008	0.031	0.016	0.016	0.028	0.014	0.014	0.025
Tues/Wed/Thurs	0	0.006	0.022	0.029	0.004	0.023	0.029	0.012	0.006	0.017	0.008	0.014	0.029	0.023	0.007	0.018	0.009	0.025	0.037	0.006	0.022	0.031
Tues/Wed/Thurs	1	0.003	0.022	0.029	0.001	0.024	0.032	0.012	0.005	0.015	0.004	0.011	0.027	0.025	0.006	0.015	0.005	0.023	0.036	0.003	0.021	0.030
Tues/Wed/Thurs	2	0.002	0.023	0.029	0.001	0.025	0.032	0.013	0.006	0.014	0.004	0.011	0.027	0.027	0.006	0.013	0.004	0.023	0.036	0.002	0.021	0.030
Tues/Wed/Thurs	3	0.003	0.025	0.031	0.001	0.027	0.034	0.014	0.009	0.015	0.005	0.013	0.029	0.029	0.009	0.013	0.005	0.025	0.037	0.003	0.023	0.031

		Santa Clara			Santa Cruz			Shasta			Sierra			Siskiyou			Solano			Sonoma		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Tues/Wed/Thurs	4	0.007	0.028	0.034	0.006	0.029	0.036	0.018	0.017	0.017	0.010	0.018	0.031	0.032	0.014	0.016	0.013	0.030	0.041	0.011	0.028	0.036
Tues/Wed/Thurs	5	0.025	0.036	0.042	0.026	0.032	0.038	0.023	0.026	0.022	0.022	0.029	0.037	0.035	0.021	0.020	0.035	0.042	0.048	0.034	0.040	0.044
Tues/Wed/Thurs	6	0.050	0.047	0.052	0.065	0.040	0.045	0.030	0.042	0.030	0.042	0.047	0.044	0.038	0.033	0.027	0.050	0.050	0.052	0.056	0.052	0.049
Tues/Wed/Thurs	7	0.067	0.055	0.059	0.084	0.055	0.056	0.038	0.051	0.039	0.060	0.061	0.050	0.040	0.046	0.036	0.061	0.057	0.054	0.068	0.059	0.054
Tues/Wed/Thurs	8	0.069	0.058	0.061	0.080	0.055	0.055	0.042	0.061	0.048	0.060	0.062	0.051	0.042	0.056	0.046	0.056	0.056	0.055	0.063	0.060	0.056
Tues/Wed/Thurs	9	0.065	0.055	0.055	0.074	0.054	0.056	0.047	0.064	0.058	0.055	0.060	0.050	0.044	0.066	0.057	0.053	0.056	0.055	0.055	0.055	0.053
Tues/Wed/Thurs	10	0.055	0.053	0.054	0.062	0.052	0.053	0.051	0.067	0.066	0.056	0.061	0.051	0.045	0.071	0.065	0.052	0.057	0.055	0.051	0.053	0.052
Tues/Wed/Thurs	11	0.051	0.053	0.053	0.057	0.053	0.055	0.054	0.070	0.069	0.059	0.064	0.052	0.047	0.076	0.070	0.052	0.057	0.054	0.050	0.054	0.052
Tues/Wed/Thurs	12	0.051	0.055	0.053	0.054	0.057	0.055	0.058	0.072	0.067	0.061	0.065	0.053	0.050	0.076	0.070	0.054	0.057	0.053	0.052	0.055	0.053
Tues/Wed/Thurs	13	0.054	0.056	0.052	0.054	0.058	0.054	0.061	0.074	0.066	0.064	0.066	0.053	0.052	0.077	0.069	0.057	0.057	0.051	0.054	0.056	0.054
Tues/Wed/Thurs	14	0.061	0.059	0.052	0.058	0.061	0.056	0.065	0.077	0.063	0.068	0.068	0.053	0.057	0.081	0.067	0.064	0.058	0.049	0.062	0.059	0.054
Tues/Wed/Thurs	15	0.067	0.063	0.054	0.062	0.061	0.055	0.070	0.080	0.061	0.073	0.069	0.053	0.058	0.078	0.064	0.070	0.058	0.046	0.067	0.063	0.056
Tues/Wed/Thurs	16	0.070	0.064	0.053	0.065	0.060	0.053	0.072	0.072	0.058	0.075	0.067	0.052	0.057	0.072	0.061	0.073	0.056	0.043	0.070	0.060	0.051
Tues/Wed/Thurs	17	0.072	0.062	0.051	0.067	0.057	0.047	0.065	0.057	0.056	0.074	0.063	0.050	0.056	0.060	0.057	0.072	0.052	0.039	0.071	0.057	0.046
Tues/Wed/Thurs	18	0.065	0.052	0.042	0.058	0.050	0.043	0.060	0.044	0.052	0.059	0.048	0.044	0.053	0.046	0.053	0.058	0.043	0.033	0.062	0.047	0.039
Tues/Wed/Thurs	19	0.053	0.037	0.030	0.041	0.041	0.034	0.053	0.032	0.045	0.043	0.034	0.038	0.048	0.033	0.044	0.046	0.034	0.028	0.048	0.035	0.031
Tues/Wed/Thurs	20	0.038	0.027	0.024	0.029	0.032	0.028	0.047	0.024	0.039	0.035	0.025	0.034	0.045	0.025	0.038	0.038	0.028	0.024	0.038	0.027	0.026
Tues/Wed/Thurs	21	0.032	0.021	0.021	0.024	0.024	0.021	0.042	0.021	0.034	0.029	0.019	0.031	0.038	0.018	0.032	0.032	0.023	0.022	0.033	0.022	0.024
Tues/Wed/Thurs	22	0.023	0.016	0.019	0.017	0.018	0.019	0.031	0.013	0.028	0.020	0.013	0.029	0.032	0.014	0.026	0.025	0.018	0.023	0.024	0.017	0.022
Tues/Wed/Thurs	23	0.014	0.011	0.020	0.009	0.012	0.015	0.022	0.010	0.022	0.013	0.009	0.028	0.025	0.010	0.021	0.016	0.015	0.028	0.015	0.013	0.024
Friday	0	0.007	0.022	0.032	0.005	0.023	0.030	0.013	0.007	0.021	0.007	0.014	0.032	0.021	0.007	0.019	0.009	0.025	0.040	0.008	0.022	0.033
Friday	1	0.004	0.023	0.031	0.002	0.022	0.031	0.012	0.005	0.018	0.005	0.011	0.030	0.023	0.006	0.017	0.006	0.024	0.039	0.004	0.021	0.031
Friday	2	0.003	0.024	0.032	0.001	0.024	0.032	0.012	0.006	0.018	0.004	0.011	0.030	0.024	0.007	0.016	0.005	0.024	0.039	0.003	0.022	0.032
Friday	3	0.003	0.025	0.033	0.002	0.027	0.034	0.014	0.008	0.018	0.005	0.012	0.030	0.026	0.009	0.016	0.005	0.025	0.040	0.004	0.023	0.033
Friday	4	0.007	0.029	0.036	0.005	0.030	0.038	0.016	0.015	0.021	0.008	0.016	0.033	0.029	0.013	0.019	0.011	0.030	0.044	0.010	0.028	0.036
Friday	5	0.022	0.035	0.044	0.022	0.033	0.041	0.023	0.023	0.026	0.017	0.026	0.038	0.032	0.018	0.023	0.027	0.040	0.050	0.030	0.039	0.044
Friday	6	0.044	0.045	0.053	0.054	0.040	0.046	0.029	0.035	0.033	0.033	0.040	0.045	0.033	0.030	0.032	0.039	0.047	0.053	0.050	0.049	0.050
Friday	7	0.060	0.052	0.058	0.075	0.049	0.055	0.034	0.044	0.041	0.049	0.054	0.050	0.037	0.039	0.039	0.050	0.053	0.056	0.063	0.057	0.055
Friday	8	0.063	0.054	0.060	0.071	0.047	0.050	0.039	0.055	0.049	0.051	0.057	0.052	0.040	0.051	0.049	0.048	0.054	0.057	0.059	0.057	0.056
Friday	9	0.060	0.054	0.057	0.068	0.049	0.051	0.042	0.060	0.055	0.050	0.057	0.052	0.045	0.063	0.054	0.048	0.055	0.057	0.053	0.054	0.054
Friday	10	0.054	0.053	0.056	0.061	0.051	0.053	0.049	0.063	0.058	0.054	0.061	0.054	0.048	0.069	0.060	0.052	0.056	0.056	0.051	0.053	0.053
Friday	11	0.053	0.055	0.056	0.061	0.056	0.054	0.052	0.069	0.061	0.060	0.066	0.055	0.049	0.072	0.063	0.056	0.058	0.055	0.053	0.055	0.054
Friday	12	0.055	0.057	0.056	0.058	0.056	0.053	0.057	0.070	0.061	0.063	0.067	0.055	0.052	0.074	0.063	0.059	0.058	0.053	0.056	0.057	0.055
Friday	13	0.058	0.058	0.054	0.060	0.059	0.058	0.057	0.075	0.061	0.066	0.068	0.054	0.055	0.077	0.062	0.063	0.058	0.051	0.058	0.058	0.056
Friday	14	0.064	0.061	0.053	0.064	0.062	0.056	0.065	0.080	0.060	0.070	0.070	0.054	0.059	0.080	0.063	0.067	0.058	0.048	0.064	0.059	0.056
Friday	15	0.067	0.063	0.054	0.065	0.061	0.055	0.070	0.082	0.059	0.073	0.070	0.052	0.063	0.081	0.061	0.069	0.057	0.045	0.066	0.062	0.056
Friday	16	0.069	0.062	0.051	0.065	0.062	0.054	0.072	0.073	0.057	0.074	0.067	0.050	0.058	0.075	0.059	0.070	0.054	0.041	0.067	0.059	0.050
Friday	17	0.069	0.060	0.048	0.064	0.059	0.049	0.065	0.062	0.055	0.072	0.063	0.047	0.059	0.063	0.055	0.067	0.050	0.037	0.067	0.055	0.046
Friday	18	0.063	0.049	0.038	0.056	0.053	0.046	0.061	0.047	0.051	0.063	0.051	0.042	0.054	0.052	0.051	0.061	0.044	0.031	0.060	0.047	0.039
Friday	19	0.053	0.037	0.028	0.044	0.043	0.035	0.059	0.039	0.046	0.050	0.039	0.035	0.050	0.036	0.046	0.054	0.037	0.026	0.049	0.036	0.030
Friday	20	0.039	0.028	0.021	0.032	0.034	0.027	0.051	0.028	0.040	0.041	0.029	0.030	0.046	0.030	0.041	0.047	0.031	0.022	0.040	0.029	0.023
Friday	21	0.033	0.022	0.018	0.027	0.027	0.022	0.045	0.022	0.035	0.037	0.023	0.028	0.040	0.022	0.036	0.039	0.025	0.020	0.035	0.023	0.020
Friday	22	0.028	0.017	0.016	0.023	0.019	0.016	0.037	0.018	0.031	0.030	0.017	0.026	0.031	0.016	0.031	0.030	0.020	0.020	0.030	0.019	0.019
Friday	23	0.021	0.013	0.016	0.015	0.014	0.013	0.026	0.012	0.025	0.019	0.011	0.024	0.025	0.012	0.025	0.021	0.016	0.022	0.022	0.015	0.020
Saturday	0	0.015	0.029	0.046	0.009	0.028	0.038	0.015	0.011	0.021	0.013	0.019	0.038	0.026	0.013	0.020	0.014	0.031	0.057	0.015	0.030	0.044
Saturday	1	0.009	0.028	0.042	0.005	0.028	0.038	0.014	0.008	0.018	0.008	0.015	0.034	0.026	0.008	0.016	0.009	0.028	0.052	0.009	0.027	0.040
Saturday	2	0.007	0.028	0.040	0.003	0.029	0.042	0.014	0.008	0.016	0.006	0.014	0.032	0.027	0.007	0.015	0.007	0.027	0.049	0.006	0.026	0.039
Saturday	3	0.005	0.029	0.038	0.002	0.032	0.042	0.014	0.007	0.016	0.006	0.013	0.031	0.030	0.007	0.014	0.006	0.026	0.046	0.005	0.025	0.037
Saturday	4	0.006	0.030	0.039	0.003	0.032	0.042	0.017	0.014	0.017	0.007	0.014	0.032	0.029	0.009	0.016	0.008	0.028	0.047	0.006	0.027	0.037
Saturday	5	0.011	0.033	0.042	0.009	0.035	0.041	0.021	0.018	0.021	0.011	0.018	0.034	0.033	0.015	0.019	0.014	0.031	0.049	0.013	0.030	0.040
Saturday	6	0.020	0.037	0.046	0.019	0.034	0.043	0.025	0.027	0.028	0.019	0.026	0.039	0.036	0.023	0.025	0.022	0.037	0.052	0.023	0.035	0.042
Saturday	7	0.032	0.041	0.050	0.033	0.038	0.041	0.032	0.038	0.039	0.032	0.038	0.046	0.038	0.033	0.036	0.032	0.042	0.054	0.034	0.041	0.047

		Santa Clara			Santa Cruz			Shasta			Sierra			Siskiyou			Solano			Sonoma		
Day of Week	**Hour**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**
Saturday	8	0.045	0.046	0.053	0.049	0.041	0.046	0.040	0.055	0.051	0.045	0.051	0.052	0.041	0.047	0.047	0.044	0.049	0.056	0.046	0.047	0.049
Saturday	9	0.055	0.051	0.056	0.059	0.046	0.046	0.044	0.064	0.061	0.057	0.062	0.056	0.045	0.063	0.059	0.056	0.054	0.055	0.055	0.051	0.050
Saturday	10	0.062	0.054	0.056	0.066	0.047	0.047	0.051	0.071	0.067	0.067	0.071	0.060	0.049	0.075	0.067	0.065	0.057	0.052	0.061	0.054	0.051
Saturday	11	0.067	0.057	0.056	0.068	0.052	0.052	0.058	0.077	0.068	0.074	0.076	0.061	0.050	0.084	0.073	0.068	0.058	0.050	0.065	0.056	0.052
Saturday	12	0.069	0.057	0.054	0.067	0.053	0.050	0.060	0.076	0.067	0.075	0.075	0.060	0.053	0.083	0.071	0.067	0.057	0.047	0.066	0.058	0.055
Saturday	13	0.069	0.057	0.051	0.067	0.055	0.049	0.059	0.073	0.066	0.075	0.074	0.057	0.055	0.081	0.069	0.066	0.056	0.044	0.067	0.059	0.058
Saturday	14	0.069	0.057	0.049	0.069	0.053	0.049	0.065	0.076	0.066	0.074	0.071	0.055	0.057	0.076	0.065	0.066	0.055	0.041	0.067	0.058	0.057
Saturday	15	0.069	0.057	0.045	0.072	0.056	0.049	0.067	0.073	0.064	0.072	0.068	0.051	0.060	0.074	0.062	0.066	0.054	0.038	0.068	0.057	0.051
Saturday	16	0.068	0.055	0.043	0.074	0.055	0.048	0.065	0.069	0.059	0.070	0.064	0.048	0.056	0.070	0.058	0.066	0.053	0.034	0.068	0.056	0.047
Saturday	17	0.067	0.052	0.038	0.074	0.055	0.046	0.064	0.062	0.055	0.066	0.057	0.044	0.055	0.061	0.057	0.065	0.050	0.031	0.067	0.054	0.044
Saturday	18	0.061	0.047	0.034	0.066	0.052	0.040	0.061	0.048	0.050	0.056	0.047	0.038	0.051	0.049	0.052	0.058	0.046	0.029	0.060	0.048	0.036
Saturday	19	0.050	0.040	0.029	0.054	0.045	0.035	0.059	0.041	0.044	0.046	0.037	0.033	0.049	0.038	0.045	0.050	0.040	0.026	0.049	0.041	0.029
Saturday	20	0.042	0.035	0.025	0.044	0.041	0.033	0.050	0.031	0.036	0.040	0.030	0.028	0.042	0.031	0.038	0.045	0.036	0.023	0.043	0.036	0.025
Saturday	21	0.040	0.031	0.023	0.039	0.037	0.032	0.044	0.023	0.030	0.035	0.025	0.025	0.037	0.023	0.031	0.041	0.033	0.023	0.041	0.033	0.024
Saturday	22	0.036	0.027	0.023	0.032	0.031	0.028	0.034	0.017	0.024	0.028	0.019	0.023	0.031	0.017	0.026	0.035	0.029	0.023	0.037	0.029	0.023
Saturday	23	0.026	0.022	0.022	0.020	0.025	0.025	0.026	0.013	0.019	0.020	0.014	0.021	0.023	0.012	0.019	0.026	0.023	0.023	0.028	0.024	0.022
Holiday	0	0.012	0.025	0.032	0.008	0.024	0.031	0.014	0.008	0.015	0.010	0.016	0.028	0.024	0.008	0.015	0.013	0.029	0.038	0.013	0.027	0.034
Holiday	1	0.007	0.025	0.031	0.003	0.025	0.034	0.013	0.007	0.013	0.006	0.013	0.027	0.027	0.008	0.012	0.008	0.027	0.038	0.007	0.026	0.033
Holiday	2	0.004	0.026	0.032	0.002	0.025	0.034	0.013	0.006	0.012	0.004	0.012	0.026	0.024	0.008	0.012	0.005	0.025	0.037	0.004	0.025	0.033
Holiday	3	0.003	0.027	0.032	0.001	0.024	0.029	0.013	0.006	0.012	0.005	0.013	0.027	0.029	0.010	0.013	0.005	0.026	0.037	0.003	0.025	0.033
Holiday	4	0.005	0.029	0.034	0.004	0.030	0.034	0.016	0.013	0.014	0.008	0.016	0.029	0.029	0.012	0.014	0.008	0.028	0.039	0.007	0.029	0.035
Holiday	5	0.014	0.034	0.038	0.012	0.033	0.041	0.020	0.017	0.020	0.014	0.023	0.032	0.031	0.016	0.017	0.018	0.034	0.043	0.017	0.034	0.039
Holiday	6	0.027	0.039	0.044	0.028	0.037	0.045	0.025	0.028	0.026	0.025	0.033	0.036	0.037	0.025	0.023	0.025	0.040	0.046	0.029	0.040	0.044
Holiday	7	0.039	0.043	0.048	0.043	0.035	0.038	0.030	0.037	0.036	0.036	0.044	0.042	0.038	0.033	0.031	0.032	0.045	0.050	0.038	0.045	0.047
Holiday	8	0.050	0.048	0.052	0.052	0.048	0.053	0.036	0.051	0.046	0.046	0.053	0.048	0.040	0.049	0.040	0.041	0.050	0.053	0.045	0.050	0.051
Holiday	9	0.054	0.052	0.054	0.058	0.051	0.053	0.047	0.068	0.056	0.054	0.059	0.050	0.043	0.062	0.054	0.051	0.055	0.055	0.049	0.053	0.052
Holiday	10	0.058	0.055	0.056	0.064	0.049	0.054	0.051	0.068	0.064	0.065	0.069	0.053	0.050	0.076	0.060	0.062	0.060	0.055	0.056	0.056	0.053
Holiday	11	0.061	0.058	0.057	0.069	0.055	0.050	0.059	0.083	0.069	0.074	0.074	0.057	0.047	0.084	0.068	0.068	0.063	0.056	0.062	0.059	0.055
Holiday	12	0.063	0.060	0.057	0.067	0.057	0.059	0.066	0.081	0.071	0.077	0.074	0.056	0.053	0.083	0.070	0.070	0.061	0.054	0.067	0.061	0.056
Holiday	13	0.066	0.062	0.057	0.068	0.069	0.064	0.062	0.084	0.068	0.076	0.074	0.058	0.062	0.091	0.067	0.071	0.062	0.052	0.070	0.062	0.056
Holiday	14	0.069	0.062	0.056	0.073	0.058	0.060	0.069	0.076	0.064	0.075	0.073	0.056	0.059	0.087	0.069	0.072	0.060	0.051	0.073	0.062	0.057
Holiday	15	0.071	0.062	0.054	0.072	0.070	0.056	0.065	0.081	0.061	0.074	0.070	0.055	0.057	0.079	0.065	0.068	0.056	0.046	0.071	0.061	0.054
Holiday	16	0.072	0.060	0.051	0.071	0.059	0.052	0.070	0.068	0.061	0.072	0.066	0.054	0.056	0.072	0.062	0.066	0.054	0.044	0.070	0.057	0.050
Holiday	17	0.071	0.057	0.047	0.070	0.058	0.048	0.068	0.063	0.060	0.068	0.059	0.051	0.056	0.058	0.060	0.064	0.050	0.040	0.067	0.053	0.044
Holiday	18	0.064	0.048	0.039	0.063	0.054	0.045	0.063	0.047	0.055	0.057	0.049	0.045	0.053	0.044	0.058	0.058	0.042	0.034	0.059	0.045	0.038
Holiday	19	0.054	0.038	0.032	0.052	0.035	0.029	0.056	0.035	0.048	0.047	0.036	0.041	0.048	0.029	0.049	0.051	0.037	0.029	0.051	0.036	0.031
Holiday	20	0.045	0.031	0.026	0.043	0.035	0.027	0.050	0.028	0.041	0.039	0.029	0.037	0.044	0.024	0.045	0.047	0.031	0.025	0.046	0.031	0.028
Holiday	21	0.039	0.025	0.024	0.036	0.029	0.026	0.045	0.021	0.035	0.030	0.020	0.033	0.040	0.019	0.040	0.042	0.026	0.024	0.041	0.026	0.026
Holiday	22	0.031	0.019	0.022	0.024	0.021	0.022	0.027	0.013	0.029	0.023	0.015	0.031	0.031	0.014	0.030	0.033	0.022	0.025	0.033	0.021	0.025
Holiday	23	0.020	0.014	0.024	0.015	0.016	0.015	0.022	0.010	0.023	0.015	0.010	0.029	0.024	0.009	0.024	0.022	0.018	0.029	0.021	0.017	0.026

		Stanislaus			Sutter			Tehama			Trinity			Tulare			Tuolumne			Ventura		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Sunday	0	0.014	0.025	0.037	0.013	0.020	0.031	0.013	0.008	0.016	0.019	0.009	0.017	0.022	0.015	0.017	0.010	0.014	0.032	0.014	0.036	0.048
Sunday	1	0.009	0.019	0.032	0.008	0.016	0.028	0.013	0.006	0.013	0.021	0.007	0.014	0.024	0.015	0.009	0.007	0.011	0.024	0.009	0.026	0.042
Sunday	2	0.007	0.016	0.029	0.006	0.013	0.026	0.012	0.006	0.011	0.022	0.006	0.013	0.023	0.011	0.008	0.005	0.011	0.022	0.006	0.021	0.038
Sunday	3	0.005	0.015	0.028	0.005	0.012	0.025	0.012	0.005	0.011	0.022	0.005	0.013	0.023	0.009	0.010	0.004	0.010	0.021	0.004	0.018	0.036
Sunday	4	0.006	0.016	0.028	0.005	0.012	0.025	0.015	0.007	0.013	0.023	0.006	0.013	0.024	0.010	0.018	0.004	0.010	0.020	0.004	0.018	0.035
Sunday	5	0.010	0.019	0.029	0.008	0.015	0.027	0.018	0.012	0.018	0.025	0.008	0.016	0.026	0.018	0.025	0.007	0.013	0.021	0.008	0.021	0.036
Sunday	6	0.015	0.023	0.031	0.013	0.020	0.030	0.021	0.019	0.026	0.028	0.014	0.024	0.030	0.031	0.042	0.012	0.019	0.026	0.014	0.027	0.038
Sunday	7	0.021	0.029	0.035	0.022	0.028	0.034	0.029	0.030	0.039	0.030	0.022	0.034	0.034	0.035	0.050	0.019	0.023	0.029	0.022	0.034	0.041
Sunday	8	0.031	0.038	0.040	0.034	0.041	0.040	0.037	0.043	0.053	0.033	0.036	0.048	0.035	0.042	0.052	0.032	0.035	0.038	0.034	0.044	0.044
Sunday	9	0.043	0.050	0.047	0.048	0.055	0.046	0.043	0.055	0.067	0.036	0.052	0.062	0.040	0.057	0.047	0.051	0.051	0.053	0.049	0.057	0.047
Sunday	10	0.055	0.060	0.051	0.064	0.068	0.052	0.053	0.071	0.079	0.040	0.071	0.075	0.044	0.066	0.054	0.067	0.067	0.071	0.065	0.070	0.050
Sunday	11	0.063	0.065	0.054	0.075	0.075	0.055	0.060	0.077	0.080	0.044	0.082	0.086	0.047	0.070	0.055	0.080	0.081	0.085	0.074	0.076	0.051
Sunday	12	0.070	0.070	0.055	0.082	0.079	0.058	0.064	0.084	0.077	0.049	0.089	0.088	0.051	0.076	0.058	0.083	0.081	0.076	0.078	0.077	0.051
Sunday	13	0.075	0.071	0.056	0.084	0.079	0.058	0.066	0.083	0.070	0.054	0.090	0.080	0.054	0.073	0.070	0.085	0.082	0.074	0.080	0.074	0.049
Sunday	14	0.077	0.069	0.055	0.084	0.077	0.057	0.067	0.085	0.065	0.058	0.089	0.072	0.056	0.071	0.068	0.085	0.083	0.069	0.079	0.068	0.047
Sunday	15	0.078	0.070	0.053	0.082	0.073	0.057	0.072	0.083	0.061	0.063	0.087	0.069	0.059	0.071	0.067	0.084	0.081	0.066	0.077	0.062	0.045
Sunday	16	0.077	0.067	0.052	0.079	0.068	0.055	0.073	0.080	0.058	0.064	0.081	0.059	0.060	0.066	0.066	0.082	0.079	0.060	0.075	0.057	0.043
Sunday	17	0.075	0.062	0.049	0.072	0.062	0.053	0.068	0.066	0.056	0.065	0.066	0.051	0.061	0.063	0.064	0.076	0.070	0.053	0.070	0.050	0.041
Sunday	18	0.068	0.055	0.046	0.060	0.052	0.049	0.065	0.056	0.049	0.065	0.055	0.044	0.060	0.052	0.056	0.064	0.056	0.043	0.062	0.040	0.038
Sunday	19	0.061	0.047	0.042	0.050	0.043	0.045	0.058	0.043	0.041	0.062	0.043	0.036	0.059	0.050	0.051	0.049	0.043	0.035	0.055	0.034	0.037
Sunday	20	0.051	0.039	0.040	0.041	0.035	0.042	0.048	0.031	0.032	0.057	0.032	0.028	0.055	0.037	0.040	0.038	0.033	0.024	0.046	0.028	0.036
Sunday	21	0.041	0.031	0.038	0.031	0.026	0.039	0.041	0.023	0.026	0.049	0.022	0.023	0.048	0.029	0.028	0.026	0.022	0.020	0.037	0.024	0.036
Sunday	22	0.029	0.024	0.036	0.021	0.019	0.036	0.031	0.016	0.021	0.041	0.015	0.019	0.038	0.018	0.029	0.017	0.014	0.017	0.026	0.020	0.035
Sunday	23	0.019	0.019	0.037	0.013	0.015	0.033	0.020	0.012	0.017	0.028	0.012	0.016	0.028	0.014	0.019	0.010	0.010	0.020	0.015	0.018	0.037
Monday	0	0.011	0.017	0.023	0.008	0.014	0.027	0.013	0.006	0.012	0.023	0.007	0.013	0.022	0.004	0.006	0.006	0.010	0.017	0.006	0.015	0.027
Monday	1	0.007	0.015	0.022	0.005	0.012	0.025	0.012	0.006	0.011	0.023	0.006	0.011	0.023	0.004	0.004	0.004	0.009	0.016	0.003	0.012	0.026
Monday	2	0.006	0.015	0.022	0.004	0.012	0.025	0.013	0.006	0.011	0.025	0.007	0.011	0.023	0.004	0.005	0.003	0.009	0.016	0.002	0.012	0.026
Monday	3	0.009	0.018	0.025	0.006	0.014	0.027	0.015	0.010	0.012	0.027	0.010	0.011	0.024	0.006	0.011	0.005	0.011	0.019	0.003	0.013	0.028
Monday	4	0.018	0.027	0.032	0.011	0.019	0.030	0.019	0.019	0.015	0.030	0.015	0.012	0.027	0.015	0.020	0.008	0.017	0.024	0.008	0.019	0.032
Monday	5	0.030	0.039	0.039	0.023	0.030	0.036	0.025	0.030	0.021	0.033	0.022	0.018	0.035	0.035	0.032	0.019	0.028	0.036	0.024	0.034	0.039
Monday	6	0.044	0.051	0.045	0.042	0.047	0.043	0.032	0.041	0.024	0.036	0.034	0.024	0.040	0.056	0.050	0.036	0.041	0.050	0.049	0.055	0.045
Monday	7	0.058	0.058	0.050	0.060	0.061	0.048	0.034	0.048	0.032	0.040	0.043	0.030	0.044	0.063	0.057	0.051	0.044	0.065	0.075	0.072	0.050
Monday	8	0.053	0.058	0.051	0.059	0.062	0.050	0.039	0.059	0.039	0.043	0.054	0.039	0.046	0.071	0.059	0.053	0.056	0.068	0.071	0.071	0.052
Monday	9	0.051	0.059	0.053	0.056	0.061	0.050	0.047	0.065	0.046	0.045	0.067	0.048	0.046	0.066	0.060	0.059	0.065	0.080	0.057	0.064	0.052
Monday	10	0.054	0.062	0.056	0.058	0.064	0.051	0.050	0.070	0.053	0.050	0.074	0.054	0.049	0.070	0.066	0.067	0.074	0.087	0.053	0.062	0.053
Monday	11	0.057	0.064	0.057	0.062	0.066	0.053	0.056	0.072	0.055	0.052	0.075	0.059	0.051	0.070	0.065	0.071	0.075	0.082	0.056	0.063	0.054
Monday	12	0.060	0.064	0.058	0.066	0.068	0.054	0.059	0.073	0.055	0.055	0.078	0.059	0.056	0.072	0.066	0.074	0.074	0.080	0.058	0.064	0.054
Monday	13	0.061	0.064	0.058	0.067	0.067	0.054	0.060	0.076	0.058	0.057	0.081	0.060	0.055	0.073	0.071	0.074	0.075	0.075	0.058	0.061	0.053
Monday	14	0.067	0.066	0.058	0.070	0.069	0.055	0.065	0.079	0.059	0.057	0.081	0.065	0.058	0.073	0.070	0.077	0.076	0.065	0.063	0.063	0.053
Monday	15	0.072	0.065	0.057	0.073	0.069	0.055	0.071	0.081	0.062	0.059	0.080	0.063	0.061	0.077	0.074	0.082	0.076	0.058	0.072	0.065	0.052
Monday	16	0.075	0.063	0.055	0.075	0.067	0.054	0.070	0.070	0.063	0.060	0.072	0.064	0.061	0.073	0.064	0.081	0.073	0.045	0.078	0.064	0.050
Monday	17	0.074	0.055	0.051	0.073	0.061	0.052	0.065	0.057	0.066	0.057	0.059	0.066	0.059	0.059	0.057	0.071	0.059	0.035	0.080	0.060	0.049
Monday	18	0.055	0.042	0.042	0.056	0.046	0.045	0.058	0.042	0.064	0.053	0.045	0.063	0.050	0.037	0.047	0.052	0.042	0.023	0.063	0.046	0.043
Monday	19	0.042	0.031	0.036	0.040	0.031	0.039	0.054	0.031	0.059	0.048	0.032	0.060	0.045	0.024	0.036	0.037	0.030	0.017	0.042	0.029	0.038
Monday	20	0.034	0.023	0.031	0.031	0.022	0.035	0.050	0.022	0.054	0.042	0.022	0.054	0.040	0.017	0.031	0.027	0.022	0.013	0.031	0.020	0.033
Monday	21	0.027	0.018	0.028	0.025	0.017	0.032	0.041	0.017	0.051	0.036	0.016	0.046	0.035	0.013	0.023	0.020	0.016	0.010	0.025	0.015	0.032
Monday	22	0.020	0.014	0.027	0.017	0.012	0.030	0.030	0.011	0.043	0.029	0.012	0.039	0.029	0.010	0.017	0.015	0.012	0.009	0.016	0.010	0.030
Monday	23	0.014	0.011	0.025	0.012	0.009	0.030	0.022	0.008	0.034	0.020	0.008	0.031	0.022	0.006	0.011	0.009	0.007	0.010	0.009	0.008	0.030
Tues/Wed/Thurs	0	0.008	0.016	0.025	0.008	0.014	0.029	0.012	0.006	0.017	0.023	0.007	0.018	0.021	0.004	0.009	0.005	0.009	0.017	0.005	0.015	0.032
Tues/Wed/Thurs	1	0.005	0.014	0.024	0.004	0.011	0.027	0.012	0.005	0.015	0.025	0.006	0.015	0.021	0.004	0.007	0.003	0.008	0.017	0.002	0.012	0.030
Tues/Wed/Thurs	2	0.005	0.014	0.025	0.004	0.011	0.027	0.013	0.006	0.014	0.027	0.006	0.013	0.022	0.004	0.009	0.002	0.009	0.017	0.001	0.012	0.030
Tues/Wed/Thurs	3	0.008	0.018	0.028	0.005	0.013	0.029	0.014	0.009	0.015	0.029	0.009	0.013	0.024	0.005	0.012	0.003	0.010	0.022	0.002	0.013	0.031

		Stanislaus			Sutter			Tehama			Trinity			Tulare			Tuolumne			Ventura		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Tues/Wed/Thurs	4	0.017	0.026	0.034	0.010	0.018	0.031	0.018	0.017	0.017	0.032	0.014	0.016	0.028	0.014	0.018	0.006	0.014	0.025	0.007	0.019	0.035
Tues/Wed/Thurs	5	0.030	0.039	0.042	0.022	0.029	0.037	0.023	0.026	0.022	0.035	0.021	0.020	0.035	0.033	0.032	0.018	0.027	0.039	0.022	0.034	0.043
Tues/Wed/Thurs	6	0.044	0.050	0.047	0.042	0.047	0.044	0.030	0.042	0.030	0.038	0.033	0.027	0.041	0.056	0.052	0.037	0.042	0.052	0.049	0.055	0.049
Tues/Wed/Thurs	7	0.059	0.059	0.052	0.060	0.061	0.050	0.038	0.051	0.039	0.040	0.046	0.036	0.044	0.067	0.060	0.053	0.047	0.064	0.075	0.072	0.052
Tues/Wed/Thurs	8	0.055	0.058	0.052	0.060	0.062	0.051	0.042	0.061	0.048	0.042	0.056	0.046	0.046	0.071	0.063	0.054	0.056	0.070	0.071	0.071	0.054
Tues/Wed/Thurs	9	0.051	0.059	0.054	0.055	0.060	0.050	0.047	0.064	0.058	0.044	0.066	0.057	0.047	0.067	0.065	0.059	0.068	0.083	0.057	0.064	0.053
Tues/Wed/Thurs	10	0.052	0.060	0.056	0.056	0.061	0.051	0.051	0.067	0.066	0.045	0.071	0.065	0.049	0.069	0.065	0.064	0.069	0.081	0.052	0.061	0.053
Tues/Wed/Thurs	11	0.054	0.061	0.057	0.059	0.064	0.052	0.054	0.070	0.069	0.047	0.076	0.070	0.052	0.071	0.062	0.068	0.069	0.077	0.054	0.062	0.053
Tues/Wed/Thurs	12	0.057	0.062	0.057	0.061	0.065	0.053	0.058	0.072	0.067	0.050	0.076	0.070	0.054	0.069	0.065	0.069	0.071	0.074	0.056	0.063	0.053
Tues/Wed/Thurs	13	0.060	0.063	0.056	0.064	0.066	0.053	0.061	0.074	0.066	0.052	0.077	0.069	0.056	0.072	0.067	0.072	0.073	0.074	0.057	0.061	0.051
Tues/Wed/Thurs	14	0.066	0.065	0.056	0.068	0.068	0.053	0.065	0.077	0.063	0.057	0.081	0.067	0.059	0.074	0.070	0.077	0.076	0.067	0.063	0.063	0.050
Tues/Wed/Thurs	15	0.073	0.066	0.055	0.073	0.069	0.053	0.070	0.080	0.061	0.058	0.078	0.064	0.061	0.080	0.071	0.084	0.078	0.058	0.071	0.065	0.049
Tues/Wed/Thurs	16	0.077	0.064	0.053	0.075	0.067	0.052	0.072	0.072	0.058	0.057	0.072	0.061	0.060	0.072	0.063	0.082	0.074	0.048	0.078	0.063	0.046
Tues/Wed/Thurs	17	0.076	0.057	0.049	0.074	0.063	0.050	0.065	0.057	0.056	0.056	0.060	0.057	0.057	0.059	0.054	0.074	0.061	0.036	0.079	0.060	0.044
Tues/Wed/Thurs	18	0.058	0.044	0.041	0.059	0.048	0.044	0.060	0.044	0.052	0.053	0.046	0.053	0.051	0.037	0.043	0.053	0.044	0.023	0.065	0.047	0.040
Tues/Wed/Thurs	19	0.044	0.032	0.034	0.043	0.034	0.038	0.053	0.032	0.045	0.048	0.033	0.044	0.045	0.025	0.036	0.038	0.031	0.016	0.044	0.031	0.034
Tues/Wed/Thurs	20	0.036	0.025	0.030	0.035	0.025	0.034	0.047	0.024	0.039	0.045	0.025	0.038	0.041	0.019	0.027	0.030	0.025	0.012	0.034	0.021	0.030
Tues/Wed/Thurs	21	0.028	0.019	0.026	0.029	0.019	0.031	0.042	0.021	0.034	0.038	0.018	0.032	0.035	0.014	0.021	0.023	0.018	0.010	0.028	0.016	0.029
Tues/Wed/Thurs	22	0.021	0.014	0.025	0.020	0.013	0.029	0.031	0.013	0.028	0.032	0.014	0.026	0.029	0.010	0.015	0.017	0.013	0.010	0.018	0.011	0.028
Tues/Wed/Thurs	23	0.015	0.012	0.023	0.013	0.009	0.028	0.022	0.010	0.022	0.025	0.010	0.021	0.022	0.006	0.011	0.010	0.008	0.010	0.010	0.008	0.030
Friday	0	0.008	0.016	0.027	0.007	0.014	0.032	0.013	0.007	0.021	0.021	0.007	0.019	0.020	0.004	0.010	0.005	0.009	0.019	0.006	0.016	0.033
Friday	1	0.006	0.014	0.025	0.005	0.011	0.030	0.012	0.005	0.018	0.023	0.006	0.017	0.021	0.003	0.007	0.003	0.008	0.019	0.003	0.013	0.031
Friday	2	0.005	0.014	0.026	0.004	0.011	0.030	0.012	0.006	0.018	0.024	0.007	0.016	0.023	0.004	0.008	0.002	0.008	0.019	0.002	0.012	0.031
Friday	3	0.008	0.017	0.029	0.005	0.012	0.030	0.014	0.008	0.018	0.026	0.009	0.016	0.022	0.005	0.013	0.002	0.008	0.021	0.003	0.014	0.032
Friday	4	0.014	0.024	0.035	0.008	0.016	0.033	0.016	0.015	0.021	0.029	0.013	0.019	0.027	0.013	0.020	0.005	0.013	0.024	0.007	0.019	0.036
Friday	5	0.024	0.035	0.042	0.017	0.026	0.038	0.023	0.023	0.026	0.032	0.018	0.023	0.034	0.032	0.033	0.013	0.023	0.037	0.020	0.032	0.042
Friday	6	0.036	0.045	0.047	0.033	0.040	0.045	0.029	0.035	0.033	0.033	0.030	0.032	0.038	0.051	0.057	0.026	0.035	0.049	0.043	0.052	0.049
Friday	7	0.049	0.053	0.052	0.049	0.054	0.050	0.034	0.044	0.041	0.037	0.039	0.039	0.042	0.062	0.063	0.039	0.040	0.060	0.067	0.068	0.052
Friday	8	0.047	0.054	0.053	0.051	0.057	0.052	0.039	0.055	0.049	0.040	0.051	0.049	0.046	0.070	0.063	0.043	0.049	0.068	0.064	0.069	0.054
Friday	9	0.047	0.056	0.055	0.050	0.057	0.052	0.042	0.060	0.055	0.045	0.063	0.054	0.047	0.066	0.063	0.049	0.057	0.073	0.054	0.062	0.053
Friday	10	0.051	0.060	0.058	0.054	0.061	0.054	0.049	0.063	0.058	0.048	0.069	0.060	0.050	0.070	0.066	0.058	0.063	0.078	0.053	0.061	0.054
Friday	11	0.054	0.062	0.060	0.060	0.066	0.055	0.052	0.069	0.061	0.049	0.072	0.063	0.052	0.071	0.063	0.064	0.069	0.077	0.057	0.064	0.054
Friday	12	0.057	0.063	0.060	0.063	0.067	0.055	0.057	0.070	0.061	0.052	0.074	0.063	0.054	0.070	0.067	0.066	0.071	0.076	0.059	0.064	0.053
Friday	13	0.061	0.065	0.059	0.066	0.068	0.054	0.057	0.075	0.061	0.055	0.077	0.062	0.056	0.072	0.067	0.071	0.074	0.077	0.061	0.065	0.052
Friday	14	0.068	0.067	0.058	0.070	0.070	0.054	0.065	0.080	0.060	0.059	0.080	0.063	0.058	0.074	0.070	0.076	0.077	0.070	0.065	0.065	0.050
Friday	15	0.074	0.067	0.056	0.073	0.070	0.052	0.070	0.082	0.059	0.063	0.081	0.061	0.059	0.075	0.068	0.083	0.079	0.060	0.071	0.065	0.049
Friday	16	0.076	0.064	0.053	0.074	0.067	0.050	0.072	0.073	0.057	0.058	0.075	0.059	0.059	0.070	0.059	0.083	0.077	0.050	0.075	0.063	0.046
Friday	17	0.075	0.058	0.048	0.072	0.063	0.047	0.065	0.062	0.055	0.059	0.063	0.055	0.055	0.057	0.055	0.075	0.064	0.038	0.074	0.059	0.043
Friday	18	0.064	0.048	0.040	0.063	0.051	0.042	0.061	0.047	0.051	0.054	0.052	0.051	0.053	0.041	0.043	0.062	0.051	0.025	0.064	0.046	0.040
Friday	19	0.052	0.037	0.032	0.050	0.039	0.035	0.059	0.039	0.046	0.050	0.036	0.046	0.045	0.027	0.036	0.050	0.039	0.018	0.048	0.032	0.034
Friday	20	0.043	0.029	0.026	0.041	0.029	0.030	0.051	0.028	0.040	0.046	0.030	0.041	0.042	0.020	0.026	0.041	0.030	0.013	0.037	0.022	0.029
Friday	21	0.035	0.022	0.022	0.037	0.023	0.028	0.045	0.022	0.035	0.040	0.022	0.036	0.039	0.017	0.019	0.036	0.025	0.010	0.032	0.017	0.027
Friday	22	0.027	0.016	0.020	0.030	0.017	0.026	0.037	0.018	0.031	0.031	0.016	0.031	0.032	0.014	0.015	0.030	0.019	0.011	0.024	0.012	0.027
Friday	23	0.020	0.012	0.018	0.019	0.011	0.024	0.026	0.012	0.025	0.025	0.012	0.025	0.026	0.011	0.010	0.018	0.012	0.009	0.016	0.009	0.027
Saturday	0	0.015	0.026	0.040	0.013	0.019	0.038	0.015	0.011	0.021	0.026	0.013	0.020	0.025	0.010	0.013	0.010	0.015	0.027	0.011	0.024	0.043
Saturday	1	0.010	0.020	0.035	0.008	0.015	0.034	0.014	0.008	0.018	0.026	0.008	0.016	0.025	0.007	0.010	0.007	0.012	0.023	0.006	0.018	0.040
Saturday	2	0.008	0.018	0.032	0.006	0.014	0.032	0.014	0.008	0.016	0.027	0.007	0.015	0.026	0.007	0.011	0.005	0.011	0.022	0.004	0.016	0.038
Saturday	3	0.008	0.019	0.032	0.006	0.013	0.031	0.014	0.007	0.016	0.030	0.007	0.014	0.027	0.009	0.013	0.004	0.010	0.025	0.003	0.015	0.037
Saturday	4	0.011	0.021	0.035	0.007	0.014	0.032	0.017	0.014	0.017	0.029	0.009	0.016	0.029	0.014	0.024	0.005	0.013	0.028	0.005	0.017	0.038
Saturday	5	0.017	0.028	0.039	0.011	0.018	0.034	0.021	0.018	0.021	0.033	0.015	0.019	0.036	0.033	0.032	0.010	0.021	0.034	0.011	0.023	0.041
Saturday	6	0.025	0.036	0.045	0.019	0.026	0.039	0.025	0.027	0.028	0.036	0.023	0.025	0.042	0.056	0.054	0.017	0.028	0.039	0.021	0.033	0.045
Saturday	7	0.034	0.044	0.050	0.032	0.038	0.046	0.032	0.038	0.039	0.038	0.033	0.036	0.041	0.055	0.068	0.029	0.036	0.053	0.034	0.046	0.050

		Stanislaus			Sutter			Tehama			Trinity			Tulare			Tuolumne			Ventura		
Day of Week	**Hour**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**
Saturday	8	0.044	0.053	0.055	0.045	0.051	0.052	0.040	0.055	0.051	0.041	0.047	0.047	0.043	0.057	0.069	0.044	0.045	0.060	0.046	0.057	0.053
Saturday	9	0.054	0.061	0.060	0.057	0.062	0.056	0.044	0.064	0.061	0.045	0.063	0.059	0.045	0.061	0.069	0.059	0.061	0.071	0.057	0.065	0.055
Saturday	10	0.062	0.068	0.063	0.067	0.071	0.060	0.051	0.071	0.067	0.049	0.075	0.067	0.048	0.066	0.068	0.073	0.074	0.078	0.065	0.071	0.056
Saturday	11	0.067	0.071	0.064	0.074	0.076	0.061	0.058	0.077	0.068	0.050	0.084	0.073	0.050	0.067	0.068	0.081	0.077	0.083	0.070	0.076	0.056
Saturday	12	0.069	0.070	0.062	0.075	0.075	0.060	0.060	0.076	0.067	0.053	0.083	0.071	0.052	0.068	0.065	0.078	0.077	0.075	0.072	0.074	0.054
Saturday	13	0.070	0.067	0.058	0.075	0.074	0.057	0.059	0.073	0.066	0.055	0.081	0.069	0.053	0.067	0.068	0.075	0.072	0.060	0.072	0.071	0.053
Saturday	14	0.070	0.064	0.054	0.074	0.071	0.055	0.065	0.076	0.066	0.057	0.076	0.065	0.055	0.070	0.070	0.075	0.068	0.055	0.072	0.068	0.050
Saturday	15	0.069	0.061	0.049	0.072	0.068	0.051	0.067	0.073	0.064	0.060	0.074	0.062	0.058	0.077	0.065	0.075	0.068	0.052	0.072	0.063	0.047
Saturday	16	0.068	0.057	0.045	0.070	0.064	0.048	0.065	0.069	0.059	0.056	0.070	0.058	0.057	0.066	0.055	0.072	0.070	0.047	0.072	0.059	0.044
Saturday	17	0.064	0.051	0.040	0.066	0.057	0.044	0.064	0.062	0.055	0.055	0.061	0.057	0.054	0.053	0.050	0.066	0.063	0.040	0.068	0.051	0.040
Saturday	18	0.056	0.042	0.033	0.056	0.047	0.038	0.061	0.048	0.050	0.051	0.049	0.052	0.052	0.040	0.039	0.058	0.052	0.031	0.059	0.041	0.035
Saturday	19	0.048	0.034	0.027	0.046	0.037	0.033	0.059	0.041	0.044	0.049	0.038	0.045	0.046	0.034	0.030	0.047	0.041	0.026	0.048	0.031	0.030
Saturday	20	0.041	0.029	0.024	0.040	0.030	0.028	0.050	0.031	0.036	0.042	0.031	0.038	0.042	0.027	0.021	0.038	0.031	0.020	0.040	0.024	0.027
Saturday	21	0.037	0.024	0.021	0.035	0.025	0.025	0.044	0.023	0.030	0.037	0.023	0.031	0.038	0.023	0.018	0.031	0.025	0.016	0.037	0.022	0.024
Saturday	22	0.031	0.020	0.019	0.028	0.019	0.023	0.034	0.017	0.024	0.031	0.017	0.026	0.032	0.019	0.011	0.025	0.020	0.018	0.031	0.019	0.023
Saturday	23	0.023	0.016	0.017	0.020	0.014	0.021	0.026	0.013	0.019	0.023	0.012	0.019	0.025	0.014	0.008	0.016	0.013	0.018	0.022	0.016	0.022
Holiday	0	0.013	0.020	0.027	0.010	0.016	0.028	0.014	0.008	0.015	0.024	0.008	0.015	0.024	0.008	0.009	0.008	0.011	0.020	0.009	0.019	0.032
Holiday	1	0.009	0.017	0.025	0.006	0.013	0.027	0.013	0.007	0.013	0.027	0.008	0.012	0.024	0.007	0.010	0.005	0.009	0.018	0.005	0.016	0.030
Holiday	2	0.007	0.015	0.024	0.004	0.012	0.026	0.013	0.006	0.012	0.024	0.008	0.012	0.023	0.006	0.007	0.003	0.010	0.018	0.003	0.014	0.029
Holiday	3	0.007	0.016	0.026	0.005	0.013	0.027	0.013	0.006	0.012	0.029	0.010	0.013	0.023	0.007	0.011	0.004	0.010	0.021	0.003	0.015	0.031
Holiday	4	0.011	0.020	0.029	0.008	0.016	0.029	0.016	0.013	0.014	0.029	0.012	0.014	0.027	0.016	0.017	0.005	0.012	0.020	0.007	0.018	0.032
Holiday	5	0.019	0.028	0.033	0.014	0.023	0.032	0.020	0.017	0.020	0.031	0.016	0.017	0.033	0.030	0.032	0.009	0.018	0.031	0.016	0.029	0.038
Holiday	6	0.027	0.035	0.038	0.025	0.033	0.036	0.025	0.028	0.026	0.037	0.025	0.023	0.035	0.045	0.052	0.018	0.023	0.038	0.031	0.042	0.043
Holiday	7	0.035	0.042	0.042	0.036	0.044	0.042	0.030	0.037	0.036	0.038	0.033	0.031	0.040	0.052	0.064	0.029	0.031	0.043	0.047	0.056	0.047
Holiday	8	0.040	0.048	0.046	0.046	0.053	0.048	0.036	0.051	0.046	0.040	0.049	0.040	0.043	0.065	0.066	0.041	0.044	0.056	0.051	0.059	0.049
Holiday	9	0.048	0.055	0.050	0.054	0.059	0.050	0.047	0.068	0.056	0.043	0.062	0.054	0.045	0.061	0.058	0.058	0.057	0.075	0.052	0.061	0.051
Holiday	10	0.059	0.064	0.055	0.065	0.069	0.053	0.051	0.068	0.064	0.050	0.076	0.060	0.050	0.075	0.055	0.076	0.083	0.087	0.059	0.066	0.053
Holiday	11	0.065	0.070	0.060	0.074	0.074	0.057	0.059	0.083	0.069	0.047	0.084	0.068	0.049	0.076	0.055	0.084	0.086	0.088	0.066	0.069	0.054
Holiday	12	0.069	0.072	0.061	0.077	0.074	0.056	0.066	0.081	0.071	0.053	0.083	0.070	0.058	0.075	0.060	0.085	0.087	0.089	0.068	0.072	0.055
Holiday	13	0.071	0.071	0.061	0.076	0.074	0.058	0.062	0.084	0.068	0.062	0.091	0.067	0.052	0.069	0.068	0.083	0.081	0.078	0.070	0.070	0.053
Holiday	14	0.072	0.069	0.059	0.075	0.073	0.056	0.069	0.076	0.064	0.059	0.087	0.069	0.055	0.069	0.070	0.080	0.074	0.068	0.071	0.068	0.053
Holiday	15	0.073	0.068	0.058	0.074	0.070	0.055	0.065	0.081	0.061	0.057	0.079	0.065	0.062	0.070	0.078	0.078	0.074	0.060	0.073	0.064	0.050
Holiday	16	0.073	0.065	0.055	0.072	0.066	0.054	0.070	0.068	0.061	0.056	0.072	0.062	0.065	0.074	0.069	0.078	0.072	0.049	0.073	0.061	0.049
Holiday	17	0.070	0.057	0.050	0.068	0.059	0.051	0.068	0.063	0.060	0.056	0.058	0.060	0.053	0.057	0.062	0.071	0.066	0.041	0.071	0.056	0.046
Holiday	18	0.060	0.046	0.044	0.057	0.049	0.045	0.063	0.047	0.055	0.053	0.044	0.058	0.051	0.040	0.046	0.057	0.049	0.033	0.061	0.045	0.041
Holiday	19	0.050	0.036	0.039	0.047	0.036	0.041	0.056	0.035	0.048	0.048	0.029	0.049	0.047	0.031	0.041	0.043	0.040	0.022	0.049	0.032	0.036
Holiday	20	0.042	0.029	0.034	0.039	0.029	0.037	0.050	0.028	0.041	0.044	0.024	0.045	0.046	0.027	0.026	0.033	0.026	0.013	0.041	0.024	0.033
Holiday	21	0.034	0.023	0.030	0.030	0.020	0.033	0.045	0.021	0.035	0.040	0.019	0.040	0.040	0.019	0.021	0.024	0.018	0.011	0.034	0.019	0.032
Holiday	22	0.027	0.017	0.028	0.023	0.015	0.031	0.027	0.013	0.029	0.031	0.014	0.030	0.034	0.014	0.014	0.017	0.012	0.009	0.025	0.014	0.031
Holiday	23	0.018	0.014	0.026	0.015	0.010	0.029	0.022	0.010	0.023	0.024	0.009	0.024	0.024	0.011	0.011	0.010	0.008	0.010	0.016	0.012	0.032

		Yolo			Yuba		
Day of Week	**Hour**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**
Sunday	0	0.016	0.026	0.044	0.013	0.020	0.031
Sunday	1	0.011	0.019	0.036	0.008	0.016	0.028
Sunday	2	0.008	0.017	0.033	0.006	0.013	0.026
Sunday	3	0.006	0.015	0.030	0.005	0.012	0.025
Sunday	4	0.007	0.016	0.029	0.005	0.012	0.025
Sunday	5	0.011	0.020	0.032	0.008	0.015	0.027
Sunday	6	0.016	0.025	0.034	0.013	0.020	0.030
Sunday	7	0.023	0.031	0.040	0.022	0.028	0.034
Sunday	8	0.034	0.041	0.046	0.034	0.041	0.040
Sunday	9	0.048	0.054	0.051	0.048	0.055	0.046
Sunday	10	0.060	0.063	0.054	0.064	0.068	0.052
Sunday	11	0.067	0.067	0.054	0.075	0.075	0.055
Sunday	12	0.071	0.070	0.053	0.082	0.079	0.058
Sunday	13	0.072	0.070	0.052	0.084	0.079	0.058
Sunday	14	0.073	0.069	0.050	0.084	0.077	0.057
Sunday	15	0.073	0.067	0.047	0.082	0.073	0.057
Sunday	16	0.072	0.063	0.045	0.079	0.068	0.055
Sunday	17	0.070	0.059	0.043	0.072	0.062	0.053
Sunday	18	0.063	0.051	0.041	0.060	0.052	0.049
Sunday	19	0.057	0.044	0.038	0.050	0.043	0.045
Sunday	20	0.051	0.038	0.036	0.041	0.035	0.042
Sunday	21	0.042	0.032	0.037	0.031	0.026	0.039
Sunday	22	0.030	0.025	0.037	0.021	0.019	0.036
Sunday	23	0.019	0.020	0.040	0.013	0.015	0.033
Monday	0	0.010	0.018	0.028	0.008	0.014	0.027
Monday	1	0.006	0.015	0.026	0.005	0.012	0.025
Monday	2	0.005	0.014	0.026	0.004	0.012	0.025
Monday	3	0.007	0.016	0.028	0.006	0.014	0.027
Monday	4	0.016	0.025	0.034	0.011	0.019	0.030
Monday	5	0.032	0.040	0.043	0.023	0.030	0.036
Monday	6	0.048	0.052	0.050	0.042	0.047	0.043
Monday	7	0.066	0.065	0.056	0.060	0.061	0.048
Monday	8	0.064	0.064	0.057	0.059	0.062	0.050
Monday	9	0.057	0.062	0.056	0.056	0.061	0.050
Monday	10	0.055	0.061	0.057	0.058	0.064	0.051
Monday	11	0.056	0.062	0.056	0.062	0.066	0.053
Monday	12	0.058	0.062	0.056	0.066	0.068	0.054
Monday	13	0.059	0.061	0.055	0.067	0.067	0.054
Monday	14	0.062	0.062	0.054	0.070	0.069	0.055
Monday	15	0.068	0.063	0.053	0.073	0.069	0.055
Monday	16	0.073	0.062	0.051	0.075	0.067	0.054
Monday	17	0.072	0.057	0.046	0.073	0.061	0.052
Monday	18	0.053	0.043	0.039	0.056	0.046	0.045
Monday	19	0.039	0.030	0.031	0.040	0.031	0.039
Monday	20	0.032	0.023	0.026	0.031	0.022	0.035
Monday	21	0.027	0.018	0.024	0.025	0.017	0.032
Monday	22	0.021	0.014	0.023	0.017	0.012	0.030
Monday	23	0.014	0.011	0.025	0.012	0.009	0.030
Tues/Wed/Thurs	0	0.009	0.017	0.031	0.008	0.014	0.029
Tues/Wed/Thurs	1	0.006	0.014	0.028	0.004	0.011	0.027
Tues/Wed/Thurs	2	0.005	0.014	0.028	0.004	0.011	0.027
Tues/Wed/Thurs	3	0.006	0.016	0.030	0.005	0.013	0.029

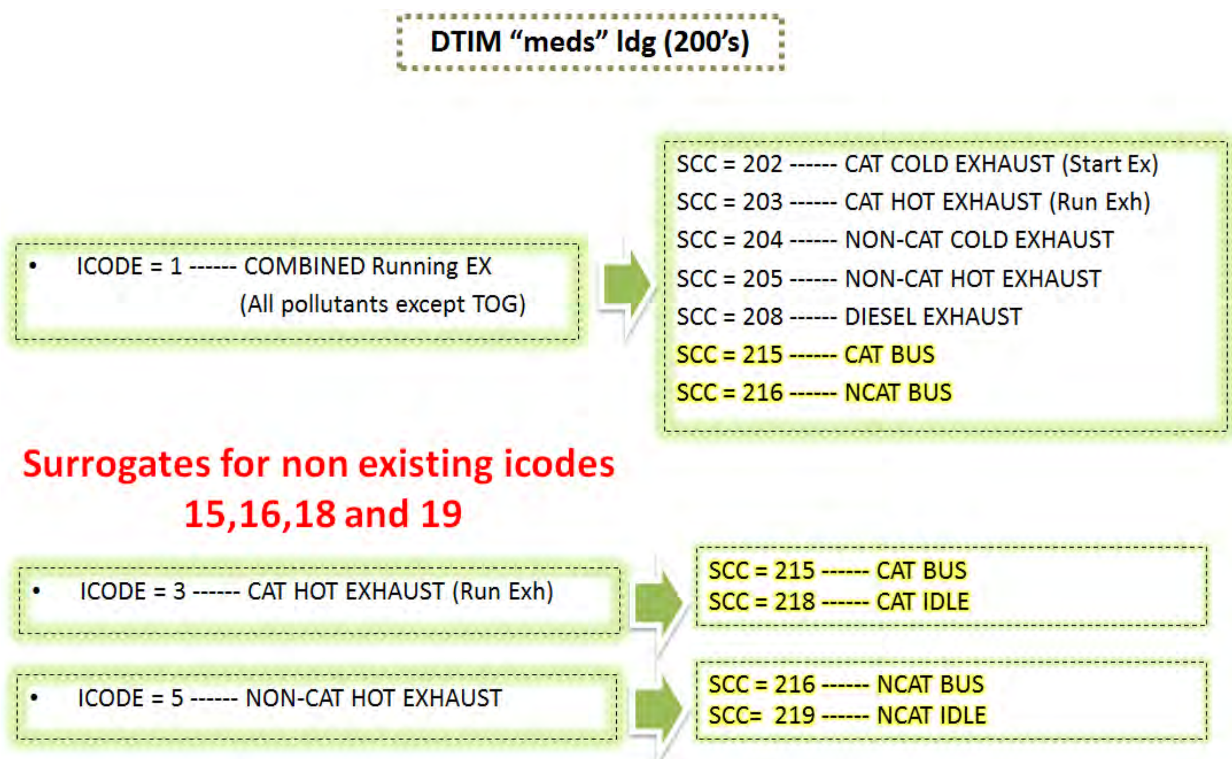
		Yolo			Yuba		
Day of Week	Hour	LD	LM	HH	LD	LM	HH
Tues/Wed/Thurs	4	0.014	0.023	0.036	0.010	0.018	0.031
Tues/Wed/Thurs	5	0.029	0.037	0.044	0.022	0.029	0.037
Tues/Wed/Thurs	6	0.046	0.051	0.052	0.042	0.047	0.044
Tues/Wed/Thurs	7	0.066	0.065	0.057	0.060	0.061	0.050
Tues/Wed/Thurs	8	0.065	0.064	0.057	0.060	0.062	0.051
Tues/Wed/Thurs	9	0.057	0.062	0.057	0.055	0.060	0.050
Tues/Wed/Thurs	10	0.053	0.061	0.057	0.056	0.061	0.051
Tues/Wed/Thurs	11	0.054	0.061	0.057	0.059	0.064	0.052
Tues/Wed/Thurs	12	0.056	0.061	0.056	0.061	0.065	0.053
Tues/Wed/Thurs	13	0.058	0.061	0.055	0.064	0.066	0.053
Tues/Wed/Thurs	14	0.062	0.062	0.053	0.068	0.068	0.053
Tues/Wed/Thurs	15	0.069	0.063	0.051	0.073	0.069	0.053
Tues/Wed/Thurs	16	0.074	0.062	0.048	0.075	0.067	0.052
Tues/Wed/Thurs	17	0.073	0.058	0.044	0.074	0.063	0.050
Tues/Wed/Thurs	18	0.056	0.045	0.037	0.059	0.048	0.044
Tues/Wed/Thurs	19	0.041	0.032	0.030	0.043	0.034	0.038
Tues/Wed/Thurs	20	0.034	0.025	0.025	0.035	0.025	0.034
Tues/Wed/Thurs	21	0.029	0.020	0.023	0.029	0.019	0.031
Tues/Wed/Thurs	22	0.022	0.015	0.022	0.020	0.013	0.029
Tues/Wed/Thurs	23	0.015	0.011	0.023	0.013	0.009	0.028
Friday	0	0.009	0.017	0.032	0.007	0.014	0.032
Friday	1	0.006	0.014	0.030	0.005	0.011	0.030
Friday	2	0.005	0.014	0.030	0.004	0.011	0.030
Friday	3	0.006	0.015	0.032	0.005	0.012	0.030
Friday	4	0.012	0.022	0.037	0.008	0.016	0.033
Friday	5	0.024	0.034	0.044	0.017	0.026	0.038
Friday	6	0.038	0.047	0.052	0.033	0.040	0.045
Friday	7	0.054	0.059	0.058	0.049	0.054	0.050
Friday	8	0.055	0.059	0.059	0.051	0.057	0.052
Friday	9	0.051	0.059	0.058	0.050	0.057	0.052
Friday	10	0.052	0.060	0.058	0.054	0.061	0.054
Friday	11	0.056	0.062	0.058	0.060	0.066	0.055
Friday	12	0.059	0.063	0.056	0.063	0.067	0.055
Friday	13	0.062	0.064	0.055	0.066	0.068	0.054
Friday	14	0.066	0.064	0.053	0.070	0.070	0.054
Friday	15	0.070	0.063	0.050	0.073	0.070	0.052
Friday	16	0.071	0.061	0.046	0.074	0.067	0.050
Friday	17	0.069	0.057	0.041	0.072	0.063	0.047
Friday	18	0.060	0.047	0.037	0.063	0.051	0.042
Friday	19	0.049	0.036	0.029	0.050	0.039	0.035
Friday	20	0.041	0.028	0.024	0.041	0.029	0.030
Friday	21	0.036	0.023	0.021	0.037	0.023	0.028
Friday	22	0.029	0.018	0.019	0.030	0.017	0.026
Friday	23	0.019	0.013	0.019	0.019	0.011	0.024
Saturday	0	0.014	0.024	0.050	0.013	0.019	0.038
Saturday	1	0.009	0.019	0.042	0.008	0.015	0.034
Saturday	2	0.008	0.017	0.039	0.006	0.014	0.032
Saturday	3	0.007	0.016	0.037	0.006	0.013	0.031
Saturday	4	0.009	0.019	0.038	0.007	0.014	0.032
Saturday	5	0.014	0.025	0.043	0.011	0.018	0.034
Saturday	6	0.023	0.033	0.049	0.019	0.026	0.039
Saturday	7	0.034	0.044	0.055	0.032	0.038	0.046

		Yolo			Yuba		
Day of Week	**Hour**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**
Saturday	8	0.046	0.055	0.059	0.045	0.051	0.052
Saturday	9	0.057	0.064	0.061	0.057	0.062	0.056
Saturday	10	0.065	0.070	0.063	0.067	0.071	0.060
Saturday	11	0.069	0.071	0.059	0.074	0.076	0.061
Saturday	12	0.069	0.068	0.056	0.075	0.075	0.060
Saturday	13	0.069	0.065	0.052	0.075	0.074	0.057
Saturday	14	0.068	0.063	0.047	0.074	0.071	0.055
Saturday	15	0.067	0.060	0.043	0.072	0.068	0.051
Saturday	16	0.066	0.056	0.039	0.070	0.064	0.048
Saturday	17	0.063	0.052	0.035	0.066	0.057	0.044
Saturday	18	0.057	0.045	0.029	0.056	0.047	0.038
Saturday	19	0.048	0.035	0.025	0.046	0.037	0.033
Saturday	20	0.042	0.030	0.021	0.040	0.030	0.028
Saturday	21	0.039	0.027	0.020	0.035	0.025	0.025
Saturday	22	0.034	0.023	0.020	0.028	0.019	0.023
Saturday	23	0.024	0.018	0.019	0.020	0.014	0.021
Holiday	0	0.012	0.022	0.032	0.010	0.016	0.028
Holiday	1	0.008	0.017	0.029	0.006	0.013	0.027
Holiday	2	0.006	0.015	0.029	0.004	0.012	0.026
Holiday	3	0.006	0.017	0.029	0.005	0.013	0.027
Holiday	4	0.011	0.021	0.032	0.008	0.016	0.029
Holiday	5	0.019	0.030	0.038	0.014	0.023	0.032
Holiday	6	0.027	0.038	0.044	0.025	0.033	0.036
Holiday	7	0.037	0.046	0.050	0.036	0.044	0.042
Holiday	8	0.046	0.054	0.053	0.046	0.053	0.048
Holiday	9	0.053	0.059	0.056	0.054	0.059	0.050
Holiday	10	0.061	0.065	0.058	0.065	0.069	0.053
Holiday	11	0.067	0.069	0.060	0.074	0.074	0.057
Holiday	12	0.069	0.068	0.059	0.077	0.074	0.056
Holiday	13	0.069	0.068	0.057	0.076	0.074	0.058
Holiday	14	0.070	0.066	0.055	0.075	0.073	0.056
Holiday	15	0.069	0.065	0.052	0.074	0.070	0.055
Holiday	16	0.067	0.060	0.049	0.072	0.066	0.054
Holiday	17	0.064	0.055	0.044	0.068	0.059	0.051
Holiday	18	0.057	0.046	0.039	0.057	0.049	0.045
Holiday	19	0.050	0.036	0.033	0.047	0.036	0.041
Holiday	20	0.044	0.029	0.028	0.039	0.029	0.037
Holiday	21	0.039	0.023	0.025	0.030	0.020	0.033
Holiday	22	0.030	0.018	0.024	0.023	0.015	0.031
Holiday	23	0.020	0.014	0.026	0.015	0.010	0.029

Appendix C: Scaling procedures after DTIM processing

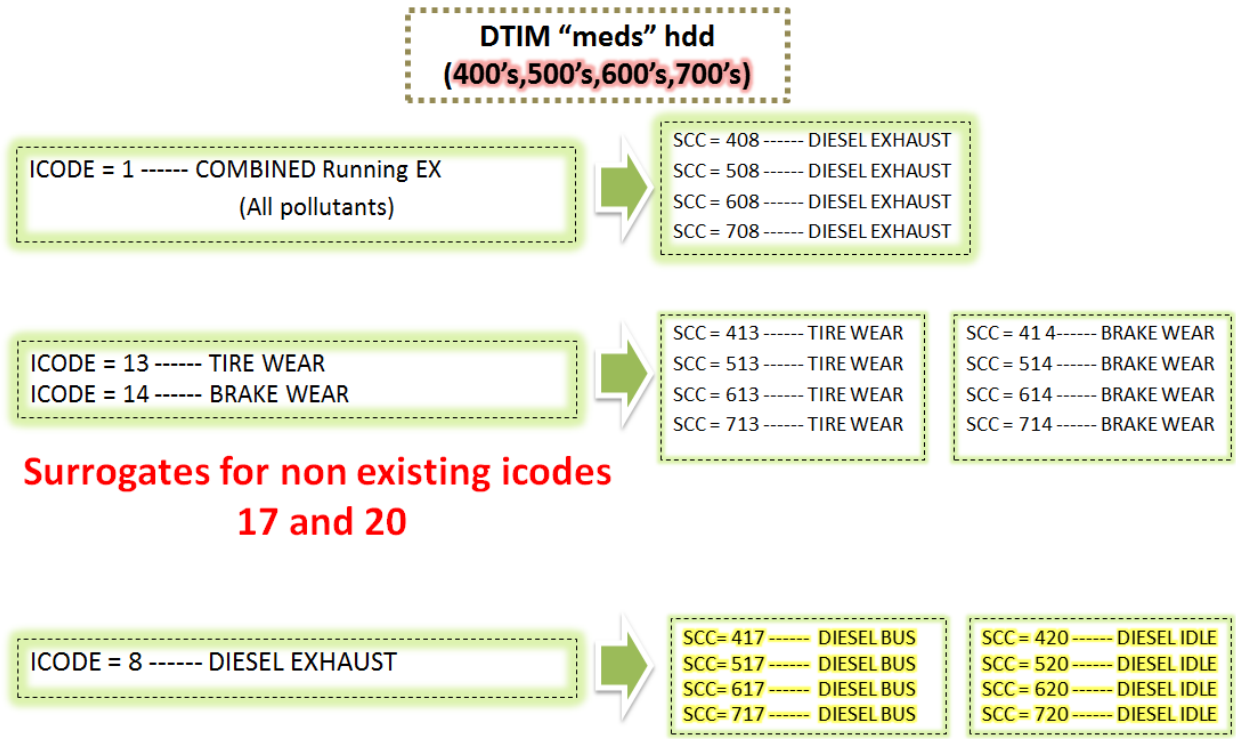
C1. Block Diagram of Scaling Process: ldg (gas: heavy- and light-duty; diesel: light-duty)

DTIM has 1 to 12 Source Classification Codes (SCC) that vary by species. For CO, NOx, SOx and PM species, DTIM only uses SCC=1 for the running exhaust emissions regardless of the fuel type and process. However, distribution of the running exhaust emissions according to the fuel type and process is needed. The following diagram explains how to distribute the running exhaust emissions for the light-duty gas. The running exhaust emissions are distributed to the catalyst cold exhaust, catalyst hot exhaust, non-catalyst cold exhaust, non-catalyst hot exhaust, catalyst bus and non-catalyst bus by using the corresponding emissions from EMFAC. Since there are no idle emissions in DTIM, surrogates are needed for the catalyst idle and non-catalyst idle. The surrogates for the catalyst idle and non-catalyst idle are catalyst hot exhaust, and non-catalyst hot exhaust, respectively.



C2. Block Diagram of Scaling Process: hdd (heavy-duty diesel)

The following diagram explains how to distribute the running exhaust emissions for heavy-duty diesel. The running exhaust emissions are distributed to the diesel exhaust or diesel bus exhaust depending on the vehicle type by using the corresponding emissions from EMFAC. Since there are no idle emissions in DTIM, a surrogate is used. The surrogate for the diesel idle emissions is diesel exhaust or diesel bus exhaust, depending on the vehicle type.



Appendix D: Additional temporal profiles

Temporal profiles developed from the AGTOOL are applied as potential replacements when processing the emissions inventories for modeling using the SMOKE processor. This would apply for agriculturally related emissions with time-invariant temporal distributions, which includes the following emission source categories: food and agricultural processing, pesticides and fertilizers, farming operations, unpaved road dust, fugitive windblown dust, managed burning and disposal, and farming equipment

Table 11 Day of week temporal profiles from the Agricultural Emissions Temporal and Spatial Allocation Tool (AgTool)

Code	M	T	W	TH	F	S	S
201	1	174	248	182	203	97	95
202	1	2	1	0	2	1	993
203	1	117	192	190	229	222	48
204	2	16	13	13	10	928	17
205	3	342	597	25	4	5	24
206	4	100	33	241	105	455	62
207	5	50	284	126	125	315	95
208	6	94	41	40	348	358	112
209	7	203	111	236	340	0	102
210	8	221	225	123	117	80	225
211	9	37	63	667	111	37	77
212	11	2	881	41	40	18	8
213	12	96	105	153	201	425	8
214	13	370	306	90	47	101	73
215	13	368	72	498	2	41	6
216	19	562	125	102	47	39	107
217	22	348	74	115	125	215	102
218	22	292	63	229	65	104	224
219	22	482	41	111	167	93	83
220	25	184	100	136	223	152	182
221	25	192	107	223	278	75	101
222	27	40	51	99	310	58	415
223	29	51	237	127	172	308	77
224	30	219	195	158	222	112	64
225	30	185	151	125	186	120	203
226	35	131	195	172	151	201	114
227	35	146	162	175	157	180	143
228	36	179	200	93	188	186	117
229	37	82	363	208	2	73	235
230	40	211	162	182	160	165	81
231	40	468	0	420	0	72	0
232	41	269	293	118	95	121	62
233	44	56	399	13	268	61	160
234	45	335	72	82	210	180	77
235	46	124	139	148	199	168	177
236	46	207	54	453	54	134	52
237	48	310	346	83	84	91	38
238	52	201	140	196	121	160	132
239	53	134	123	144	206	192	149
240	53	108	150	163	171	207	148
241	57	156	183	117	92	220	175
242	63	105	176	154	148	195	160
243	63	186	136	175	187	134	120

Code	M	T	W	TH	F	S	S
244	64	230	173	136	83	251	63
245	66	249	149	127	105	185	120
246	67	222	278	236	65	129	2
247	70	120	192	168	188	145	116
248	74	95	170	197	157	144	162
249	74	190	108	126	246	116	138
250	77	295	104	187	155	88	93
251	79	135	291	129	86	182	97
252	80	360	9	19	424	79	29
253	81	133	132	125	226	167	135
254	82	136	151	118	160	196	157
255	82	92	125	207	177	153	164
256	85	133	152	145	188	173	124
257	87	295	16	111	47	244	201
258	96	128	104	169	161	224	119
259	104	196	118	155	202	132	94
260	104	111	196	121	181	127	162
261	107	161	70	90	227	243	102
262	107	145	115	203	187	147	95
263	111	171	137	0	297	202	81
264	112	121	144	165	155	172	131
265	113	199	97	132	218	147	94
266	113	167	15	156	399	70	80
267	115	150	128	153	192	139	122
268	115	103	120	138	117	251	156
269	119	125	119	87	144	158	248
270	120	145	130	137	155	166	147
271	125	155	141	108	179	149	142
272	130	140	137	170	93	139	192
273	135	222	191	83	169	110	90
274	136	160	156	162	144	156	86
275	138	109	107	137	227	147	137
276	139	101	117	171	167	171	134
277	143	143	143	143	143	143	143
278	150	230	118	72	144	170	116
279	163	118	106	135	185	112	181
280	199	136	81	163	143	180	99
281	218	8	2	14	6	525	226
282	250	35	290	130	50	109	137
283	255	116	82	103	128	63	252
284	278	182	148	36	105	112	139
285	326	168	189	0	105	0	211
286	0	212	165	131	202	128	161
287	0	289	0	0	356	222	133
288	0	321	93	208	109	81	188
289	0	431	4	160	246	15	144
290	0	515	122	111	48	128	76
291	0	0	0	916	84	0	0
292	0	0	0	0	148	0	852
294	0	0	0	0	1000	0	0

Table 12 Daily temporal profiles from the Agricultural Emissions Temporal and Spatial Allocation Tool (AgTool)

Code	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
201	0	0	0	0	0	10	102	2	26	358	259	134	65	1	26	10	3	2	1	0	0	0	0	0
202	0	0	0	5	3	2	5	59	44	38	28	640	19	21	48	34	21	22	10	1	0	1	0	0
203	1	0	0	0	10	162	64	51	139	270	115	46	61	3	15	16	16	4	12	6	3	1	3	2
204	1	0	0	0	0	1	139	405	79	126	69	54	33	31	13	20	14	14	2	0	0	0	0	0
205	1	3	6	2	3	8	1	2	5	29	73	112	125	115	101	164	46	49	65	68	3	10	5	2
206	2	5	0	4	22	5	6	8	26	31	88	90	66	397	38	28	43	100	34	5	0	0	0	0
207	2	3	0	0	37	177	45	57	167	203	123	102	23	15	8	6	22	6	1	0	0	0	0	1
208	2	0	0	0	0	20	1	498	9	15	28	8	42	6	358	2	2	0	9	0	0	0	0	0
209	2	0	0	12	54	3	41	471	18	105	94	31	7	9	68	33	43	7	0	0	0	0	0	0
210	2	4	2	4	4	3	17	40	60	137	87	178	42	67	82	198	60	6	3	1	1	1	1	1
211	3	2	3	2	0	2	6	12	43	75	220	413	2	199	2	5	4	7	0	0	0	0	0	0
212	4	5	0	0	6	220	16	73	212	321	135	6	0	0	0	0	0	0	3	0	0	0	0	0
213	4	159	11	187	7	0	0	16	71	536	0	1	0	0	0	0	0	0	7	0	0	0	0	0
214	5	5	5	7	6	13	6	91	50	29	237	161	11	37	123	78	76	1	51	1	1	1	1	2
215	8	5	19	15	44	48	35	44	88	109	96	100	58	112	62	44	30	52	13	3	3	3	3	6
216	9	0	0	0	0	10	19	157	83	105	65	92	15	19	73	308	32	6	2	4	1	0	1	0
217	9	9	6	7	10	84	13	35	113	187	138	63	57	58	25	40	44	45	30	4	5	4	3	13
218	10	3	6	5	7	11	17	61	30	44	61	73	88	56	119	265	18	3	108	3	1	3	3	6
219	0	0	0	0	0	393	374	26	0	139	0	4	11	1	2	15	33	2	0	0	0	0	0	0
220	11	11	8	2	25	16	144	131	173	251	106	55	56	4	1	4	1	0	0	0	0	0	0	0
221	13	13	15	25	32	11	8	12	8	123	19	135	6	47	157	65	26	96	154	7	6	6	6	8
222	9	9	2	19	3	19	7	16	76	20	39	156	44	277	29	52	176	37	2	2	2	1	1	2
223	5	5	3	4	13	23	108	64	68	61	92	278	59	38	56	34	38	22	14	5	1	1	2	5
224	1	1	10	4	8	32	50	118	64	72	75	123	130	51	72	63	61	24	8	2	16	2	11	1
225	4	4	8	12	25	22	33	74	62	76	86	114	72	84	86	92	80	33	12	7	3	4	3	4
226	4	4	8	11	12	26	26	46	37	85	114	231	83	67	71	91	57	12	4	4	1	2	3	2
227	7	7	9	10	19	39	25	45	61	92	97	102	73	120	66	66	72	45	19	7	5	5	5	5
228	4	4	8	9	28	20	30	24	34	58	53	180	122	60	128	104	67	29	22	3	2	4	4	3
229	10	10	15	14	18	171	37	47	47	41	38	40	45	22	27	57	13	3	305	4	6	5	5	20
230	19	19	40	29	38	80	48	119	50	39	31	35	75	49	84	80	64	27	22	21	12	10	9	1
231	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42
232	0	0	0	0	0	2	20	24	22	21	37	146	32	41	17	219	406	5	4	4	0	1	0	0
233	0	0	0	0	0	0	0	0	512	0	0	0	0	0	488	0	0	0	0	0	0	0	0	0
234	9	9	7	5	9	32	20	58	39	80	110	105	136	66	131	41	89	12	16	9	9	0	7	1
235	2	2	2	5	6	31	48	95	72	51	41	460	48	29	19	20	34	17	9	8	1	0	0	0
236	11	11	23	12	20	28	23	22	28	64	96	55	75	53	105	105	146	58	13	11	8	10	14	9
237	18	18	12	10	15	7	11	24	20	49	77	80	54	38	59	177	120	20	10	35	38	44	39	26
238	1	1	1	4	1	20	52	86	79	118	93	120	71	56	132	73	42	27	8	4	2	3	3	1
239	2	2	1	3	2	42	31	82	79	79	87	78	85	78	76	67	142	38	15	4	1	2	2	1
240	0	0	0	19	27	55	26	23	26	51	112	162	192	112	85	60	22	8	1	12	6	0	0	1
241	3	3	7	34	3	37	32	238	35	45	66	70	64	43	166	68	52	16	4	5	1	1	4	0
242	3	3	2	35	6	40	47	69	76	97	85	95	80	78	105	42	48	56	12	4	1	15	2	0
243	0	0	0	2	18	6	70	47	130	146	115	21	62	64	247	42	22	4	2	0	0	0	1	0
244	22	22	18	16	38	65	86	87	74	83	68	64	61	34	32	51	105	25	17	10	2	2	6	12
245	6	6	5	7	16	30	26	53	78	126	75	74	33	44	63	118	131	12	8	2	68	8	8	4
246	0	0	0	1	7	426	80	147	29	25	23	109	2	29	53	6	45	0	0	0	0	17	0	0
247	0	0	5	175	1	6	0	37	49	13	4	11	250	0	1	0	439	0	0	9	0	0	0	0
248	4	4	12	8	64	229	105	285	61	59	32	42	10	71	3	4	8	0	0	0	0	0	0	0

Code	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
249	0	0	0	0	1	6	51	4	11	34	153	492	8	40	7	15	167	8	0	1	0	0	0	0
250	8	8	8	1	1	4	4	4	368	389	188	12	1	1	1	1	1	0	0	0	0	0	0	0
251	17	17	7	68	22	64	11	227	26	299	87	17	4	4	60	15	0	0	0	1	2	25	15	12
252	0	0	0	0	0	3	2	1	2	2	958	9	3	3	2	3	3	8	2	0	0	0	0	0
253	0	2	0	0	0	2	60	212	153	137	76	138	58	47	61	25	13	7	9	1	0	0	0	0
254	0	6	0	0	151	178	73	63	226	62	12	58	9	7	39	21	80	15	0	0	0	0	0	0
255	0	17	356	0	0	149	0	213	0	2	258	0	0	0	0	0	0	0	4	0	0	0	0	0
256	0	0	0	1	0	244	44	98	70	1	0	538	2	0	0	0	0	2	0	0	0	0	0	0
257	0	0	0	0	0	0	11	38	8	77	89	690	18	14	14	10	21	2	8	0	0	0	0	0
258	0	0	0	0	1	217	54	47	60	119	118	231	0	82	0	54	17	0	0	0	0	0	0	0
259	0	0	0	0	8	312	108	95	177	227	73	0	0	0	0	0	0	0	0	0	0	0	0	0
260	0	0	0	0	77	0	1	18	74	134	241	243	121	48	8	11	0	23	0	1	0	0	0	0
261	0	0	0	0	0	1	10	58	48	373	106	114	34	70	38	15	0	0	0	0	0	58	0	76
262	0	0	0	0	0	3	2	20	7	113	26	792	4	5	9	4	10	5	0	0	0	0	0	0
263	0	0	0	0	0	72	919	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
264	0	0	0	0	0	75	0	618	307	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
265	0	0	0	0	0	89	14	0	0	0	0	897	0	0	0	0	0	0	0	0	0	0	0	0
266	0	0	0	0	0	92	0	263	71	187	123	70	50	6	19	4	10	85	19	0	0	0	0	0
267	0	0	0	0	0	377	95	0	0	32	0	495	0	0	0	0	0	0	0	0	0	0	0	0
268	0	0	0	0	0	772	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	206
269	0	0	0	0	0	795	121	7	1	16	9	22	5	3	7	8	4	0	0	0	0	0	0	0
270	0	0	0	0	0	0	67	0	9	371	397	127	26	3	1	0	0	0	0	0	1	0	0	0
271	0	0	0	0	0	0	495	0	31	269	0	0	0	144	0	61	0	0	0	0	0	0	0	0
272	0	0	0	0	0	0	929	34	0	0	0	37	0	0	0	0	0	0	0	0	0	0	0	0
273	0	0	0	0	0	0	0	1	0	0	0	997	0	1	0	0	0	0	0	0	0	0	0	0
274	0	0	0	0	0	0	0	6	24	368	49	198	25	32	42	95	45	58	56	1	0	0	0	0
275	0	0	0	0	0	0	0	46	483	33	11	12	7	17	50	4	336	0	0	0	0	0	0	0
276	0	0	0	0	0	0	0	864	0	0	0	0	136	0	0	0	0	0	0	0	0	0	0	0
277	0	0	0	0	0	0	0	0	42	75	167	483	0	233	0	0	0	0	0	0	0	0	0	0
278	0	0	0	0	0	0	0	0	0	84	93	823	0	0	0	0	0	0	0	0	0	0	0	0
279	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
280	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	0	0	0	0	0	0	0
281	0	0	0	0	0	0	0	0	0	0	0	1000	0	0	0	0	0	0	0	0	0	0	0	0
282	0	0	0	0	0	0	0	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
283	0	0	0	0	0	0	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
284	0	0	0	0	0	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix H: Vehicular Impacts at the Calexico Ports of Entry

The 130-mile California-Mexico border is home to six land Ports of Entry (POEs), three located in San Diego County and three connecting Imperial County and Mexico.[1] The three Imperial County POEs include Calexico West/Mexicali I, Calexico East/Mexicali II, and Andrade/Los Algodones in the easternmost portion of the county adjacent to the California-Arizona border. The Calexico West POE is the third busiest land port in the State processing about 20,000 northbound vehicles and 12,500 pedestrian crossings per day.[2] In contrast, the Calexico East POE, located approximately 7 miles to the east of Calexico West, is the principal gateway for heavy duty commercial trucks into the Imperial Valley and is the second busiest commercial POE along the California-Mexico border, processing nearly a thousand heavy duty trucks each day.[3]

Binational airsheds along the U.S.-Mexico border present a multitude of air quality challenges given differing regulations and governmental structures between the two nations.[4] Mobile source emissions from POEs within these airsheds are of particular concern given the exposure of those living near the ports as well as pedestrians crossing the border near queues of vehicles waiting to be processed. Heavy duty trucks may consume up to a gallon of diesel fuel for each hour of idling and can create significant air quality impacts, including high levels of particulate matter and air toxics. Vehicle drivers are also impacted from emissions generated during extensive wait times that often occur at border POEs.[5] Vehicle exhaust emissions from border crossings, and their impact on the health of area residents, has been the focus of multiple studies as well as considerable media coverage.[6] Based on the most recent available emission inventory data, approximately 30 percent of NOx emissions in the Imperial County PM2.5 non-attainment area are generated by on-road transportation sources.

The Calexico West and Calexico West POEs are located approximately 1 mile southwest and 5.5 miles east of CARB's Calexico monitoring station, respectively (Figure H-1). These distances, coupled with results from receptor modelling analysis, identify mobile sources as the third largest contributor to PM2.5 concentrations measured at the Calexico station for 2011 through 2015. In addition, the Conditional Probability Function (CPF) method, which effectively provides directional information concerning emission sources, indicate that most PM2.5 from mobile and secondary nitrate sources in Calexico originate from the U.S.-Mexico border crossing areas (Figure H-2).

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[1] California State Transportation Agency; *California Freight Mobility Plan*, page 249; December 2014.
[2] U.S. General Services Administration; *Fact Sheet: Calexico West Land Port of Entry*; August 2016.
[3] California State Transportation Agency; California Freight Mobility Plan, Appendix B-5-3; December 2014.
[4] Penelope J. E. Quintana, Paul Ganster, Paula E. Stigler Granados, Gabriela Muñoz-Meléndez, Margarito Quintero-Núñez & José Guillermo Rodríguez-Ventura (2015): *Risky Borders: Traffic Pollution and Health Effects at US–Mexican Ports of Entry*, Journal of Borderlands Studies.
[5] California State Transportation Agency; *California Freight Mobility Plan*; page 252; December 2014.
[6] Brown, Patricia Leigh. "The Air Is Dark and Asthma Is Deadly Along the Mexico Border." *Reveal*. April 21, 2015. Retrieved from: https://www.revealnews.org/article/the-air-is-dark-and-asthma-is-deadly-along-the-mexico-border/.

Figure H-1. Location of Calexico POEs

Photo credit: California Department of Transportation

Figure H-2. CPF Plots for Secondary Nitrate and Mobile Emissions Measured at Calexico

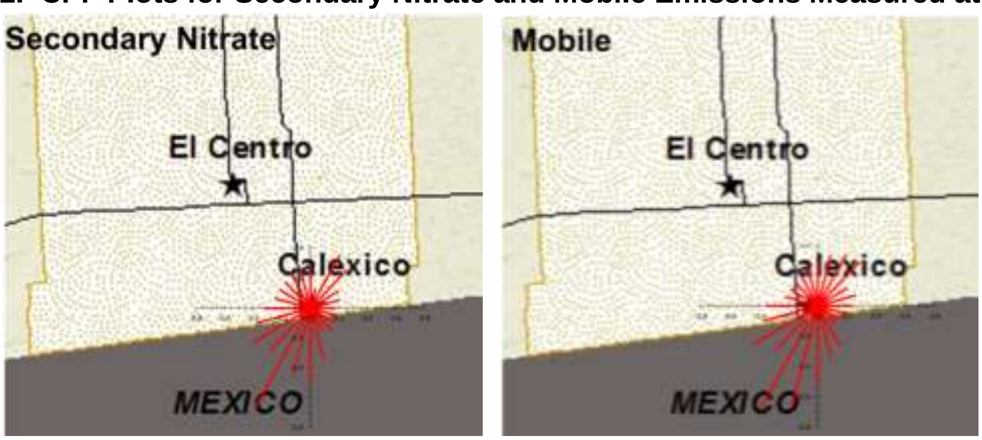
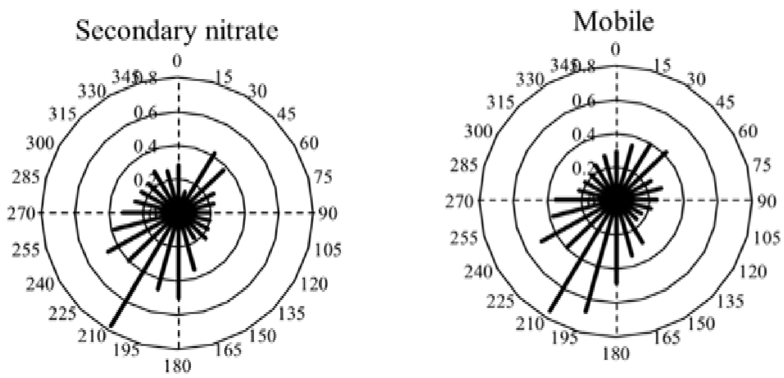


Figure H-2 Continued. CPF Plots for Secondary Nitrate and Mobile Emissions Measured at Calexico



Since 1999 Mexico has become California's top trading partner and the United States' second largest trading partner.[7] The increased cross-border trade between Mexico and California has resulted in a growing number of heavy duty trucks waiting to cross over the border. With an increase in the number of trucks, the corresponding wait times have also increased. A study published in 2015 evaluated vehicle idling emissions at the two Calexico POEs and found that wait-times averaged six to eight hours.[8] While vehicle idling emissions at the border are difficult to quantify, these extended wait-times generally suggest an increase in vehicular emissions with a potential corresponding impact on nearby residents.

The U.S. Department of Transportation tracks all vehicles entering the United States from Mexico at the Calexico West and Calexico East POE every year.[9] Table H-1 displays the numbers of vehicles and pedestrians that passed through the two Calexico POEs in 2016 by month. Significantly, for passenger vehicles, the highest numbers of crossings occurred in December which corresponds to when the highest PM2.5 concentrations occur in the Imperial County PM2.5 NA.

[7] Transportation Border Congestion Relief Program Application. California Department of Transportation. "Calexico East Port of Entry Expansion." June 2008. Retrieved from: http://www.dot.ca.gov/dist11/departments/planning/pdfs/border/08_Transportation_Border_Congestion_Relief_Program_App_Calexico_East_POE_Expansion.pdf.

[8] Kear, Tom. "Vehicle Idling Emissions Study at Calexico East and Calexico West Ports-of-Entry Final Report." October 2015. Retrieved from: http://www.co.imperial.ca.us/AirPollution/Forms%20&%20Documents/BORDER/Calexico%20POEs%20Final%20November%202,%202015.pdf.

[9] U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics, based on data from the Department of Homeland Security, U.S. Customs and Border Protection, Office of Field Operations. http://transborder.bts.gov/programs/international/transborder/TBDR_BC/TBDR_BC_Index.html

Table H-1: 2016 Border Crossing/Entry at Port Level (Monthly)

Port Name	Year	Month	Trucks	Buses	Personal Vehicles	Pedestrians
CA: Calexico West	2016	1-Jan	0	0	372,198	374,171
CA: Calexico West	2016	2-Feb	0	0	347,091	361,101
CA: Calexico West	2016	3-Mar	0	0	365,228	383,975
CA: Calexico West	2016	4-Apr	0	0	360,419	360,702
CA: Calexico West	2016	5-May	0	0	370,754	384,086
CA: Calexico West	2016	6-Jun	0	0	353,728	338,511
CA: Calexico West	2016	7-Jul	0	0	351,713	324,845
CA: Calexico West	2016	8-Aug	0	0	357,081	320,006
CA: Calexico West	2016	9-Sep	0	0	339,120	344,140
CA: Calexico West	2016	10-Oct	0	0	374,563	361,723
CA: Calexico West	2016	11-Nov	0	0	356,452	356,117
CA: Calexico West	2016	12-Dec	0	0	378,687	361,534
Total			**0**	**0**	**4,327,034**	**4,270,911**
CA: Calexico East	2016	1-Jan	28,080	257	300,838	17,685
CA: Calexico East	2016	2-Feb	29,926	248	303,402	16,192
CA: Calexico East	2016	3-Mar	31,489	260	322,055	24,649
CA: Calexico East	2016	4-Apr	30,315	241	317,059	20,318
CA: Calexico East	2016	5-May	29,427	279	336,666	19,950
CA: Calexico East	2016	6-Jun	29,756	219	311,353	12,542
CA: Calexico East	2016	7-Jul	25,942	226	311,730	13,714
CA: Calexico East	2016	8-Aug	30,241	223	310,923	12,635
CA: Calexico East	2016	9-Sep	28,142	210	307,851	25,908
CA: Calexico East	2016	10-Oct	28,634	303	326,561	22,913
CA: Calexico East	2016	11-Nov	28,602	224	330,583	27,184
CA: Calexico East	2016	12-Dec	29,173	216	350,463	40,302
Total			**349,727**	**2,906**	**3,829,484**	**253,992**
Calexico West/East Totals			**349,727**	**2,906**	**8,156,518**	**4,524,903**

The Positive Matrix Factorization analysis presented in Appendix C of the 179B Technical Demonstration document shows the average contribution from mobile sources to the three-year average PM2.5 concentration was approximately 16 percent of the total PM2.5 mass as measured at Calexico.[10] Mobile source emissions indicated a winter-high seasonal trend. In addition, the CPF plot for the mobile source category at Calexico also suggests high contributions from the nearby U.S.-Mexico border crossing area. Because of Calexico's close proximity to the U.S.-Mexico border crossing area, idling cars and trucks are a likely contributor to PM2.5 concentrations measured at the Calexico station.

[10] Average based on Calexico PM2.5 data recorded in 2011, 2012, and between September 2014 and August 2015.

Appendix I: Agricultural Burning in Imperial County

Background

In Imperial County, after vegetative material is harvested, the fields and stubble are burned to prepare for the next planting. This burning helps prevent the spread of plant diseases and controls weeds and other pests. Title 17 of the California Code of Regulations (Title 17) provides agricultural and prescribed burning guidelines for each area in California. Title 17 specifically requires the District to have rules in place that minimize smoke from agricultural burning.[1] Title 17 also identifies the meteorological criteria for regulation of agricultural and prescribed burning by air basin in order to minimize smoke impacts.

On a daily basis, the Imperial County Air Pollution Control District (District) reviews meteorological reports from various airport operators, the National Weather Service, State fire agencies, and CARB to help determine whether the day is a burn day. Burn/no burn days are declared for the entire county. The District uses a detailed map of Imperial County to ensure that burns are allocated correctly to ensure minimal-to-no smoke impacts on the public. Daily burn authorizations specify the amount, timing, and location of each burn event. The burn authorization system considers the following factors before declaring a burn day: (1) air quality; (2) meteorological conditions expected during burning, including wind speeds and directions at the surface and aloft, and atmospheric stability; (3) types and amounts of materials to be burned; (4) location and timing of materials to be burned; (5) locations of nearby smoke sensitive areas (schools, residential neighborhoods, etc.); and (6) smoke from all burning activities, including burning in neighboring air Districts or regions which may affect the District or region.

Districts Rule 701 prohibits agricultural burning on any day declared to be a no-burn day by the CARB, a fire control agency, or the District's Air Pollution Control Officer. Rule 701 also specifies the type of waste material that is allowed for burning, along with appropriate drying times, and the hours when burning may be conducted. This Rule does not allow any burning that causes a public nuisance, reduces visibility, or impacts a sensitive receptor within 1.5 miles. This restriction applies to burns within 1.5 miles of a residential area (three or more contiguous, inhabited dwellings), rural schools, or adjacent to heavily traveled roads. In addition, beginning in 2010, as part of the District's Good Neighbor Policy (Policy 37), farmers who conduct burning must notify and advise nearby neighbors (within a half mile) of a potential burn.[2]

The District submits an annual agricultural burn report to CARB in January of each year. The report includes the amount of acres and the type of crops that were burned during the previous calendar year. These reports indicate significant reductions in burning

[1] *Smoke Management Guidelines for Agricultural and Prescribed Burning*. Title 17 of the California Code of Regulations, Subchapter 2, March 14, 2001.
[2] *Good Neighbor Policy-Neighbor Notification and Traffic Re-Routing Procedures for Agricultural Burning*. Policy No. 37. https://www.arb.ca.gov/smp/district/imp2010.pdf. April 7, 2010.

since 2003 in Imperial County. Open burning in Imperial County has been reduced in quantity as well as the types of crops burned. Emphasizing public health and safety, Imperial County has successfully reduced burning from a total of 40,221 acres of all crops in 2003 to 17,647 acres in 2016, primarily consisting of grass crops (e.g., alfalfa, klein, bermuda). This represents a 56 percent reduction since 2003. Due to fluctuations in agricultural production, there have been increases and decreases in agricultural burning between years. However, agricultural burning on average has been declining.

Emissions from Agricultural Burning

Table I-1 below displays the annual and summer emissions from agricultural burning for PM2.5, ROG, NOx, and SOx. Agricultural burning contributes most to the PM2.5 and ROG emission inventories with the highest impacts occurring in the summer when agricultural burning peaks in the Imperial County PM2.5 NA. Agricultural burning contributed approximately 7 percent of total PM2.5 emissions in 2012 and decreased to approximately 2 percent of the total emissions inventory in 2014, on an annual basis.

Table I-1. Annual Average and Summer Emissions from Agricultural Burning Field Crops (tons per day - Annual and summer)

Pollutant	2012 Annual	2012 Summer	2013 Annual	2013 Summer	2014 Annual	2014 Summer
PM2.5	0.82	1.02	0.54	0.67	0.27	0.34
ROG	0.60	0.74	0.39	0.49	0.20	0.24
NOx	0.29	0.36	0.19	0.24	0.10	0.12
SOx	0.05	0.06	0.03	0.04	0.02	0.02

The 2005 Mexicali emission inventory report published by ERG estimated emissions from agricultural burning in Mexicali.[3] ERG noted that only wheat, sorghum, and irrigation canal and ditch bank weeds were burned in Mexicali. ERG estimated that 140,847 acres were subsequently burned in Mexicali in 2008. For PM2.5, the tonnage burned resulted in approximately 1,350 tons of PM2.5 emitted in the atmosphere in 2008, or 3.7 tons per day. By comparison, PM2.5 emissions estimated from agricultural burning in the Imperial County PM2.5 NA in 2014 was 0.27 tons per day.

PM2.5 Concentrations on Burn/No-Burn Days (2012-2014)

To estimate the impact of agricultural burning on ambient concentrations on an annual basis, the average PM2.5 concentrations in Calexico, El Centro, and Brawley were compared on burn days to those recorded on no-burn days. On no-burn days, the average PM2.5 concentrations at Calexico, El Centro, and Brawley for 2012 through 2014 were 13.9 $\mu g/m^3$, 7.3 $\mu g/m^3$, and 7.3 $\mu g/m^3$, respectively. On burn days, the averages were 13.6 $\mu g/m^3$ at Calexico, 7.0 $\mu g/m^3$ at El Centro, and 7.6 $\mu g/m^3$ at Brawley. For both the Calexico and El Centro PM2.5 sites, the average PM2.5

[3] Eastern Research Group, Inc., February 2009. Appendix A: Area Source Category Forms, Page I-19.

concentrations were lower on burn days. However, for the Brawley site, the average PM2.5 concentration was slightly higher on burn days. Figure I-1 shows the days in 2012 through 2014 when agricultural burning occurred and the corresponding Calexico PM2.5 concentration as measured by a Federal Reference Method sampler. Days with PM2.5 concentrations over 12.0 µg/m^3 did occur on agricultural burn days, but occurred more frequently on days when burning is prohibited in Imperial County (Figure I-2).

Figure I-1. FRM PM2.5 Concentration at Calexico on Burn Days

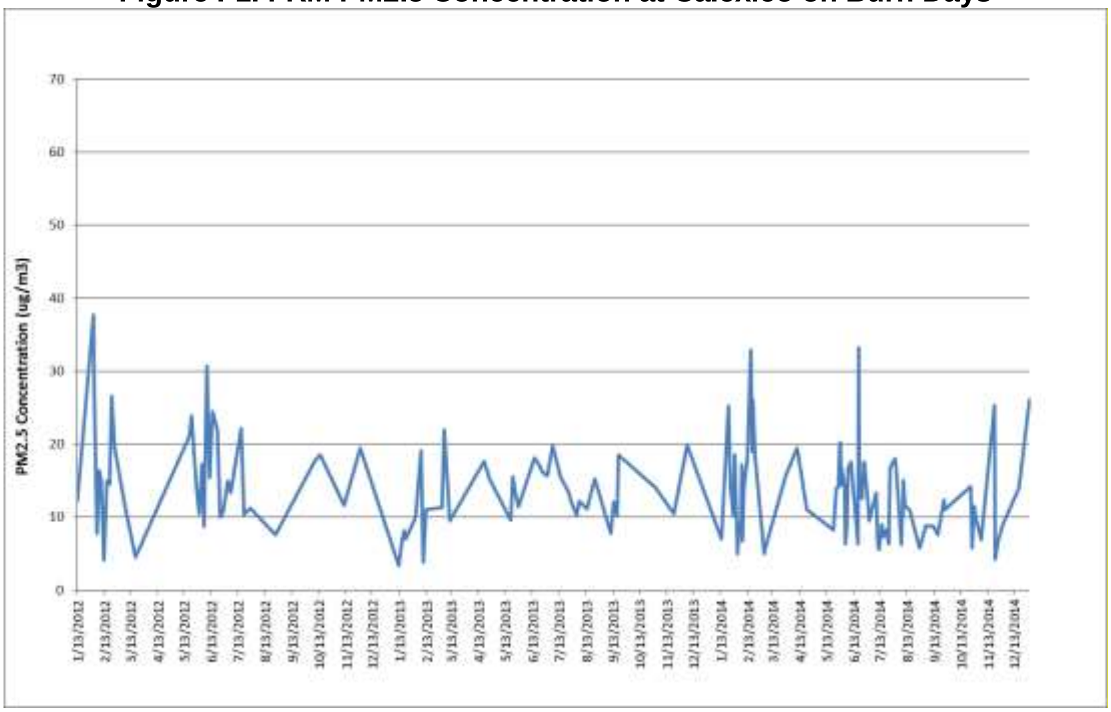
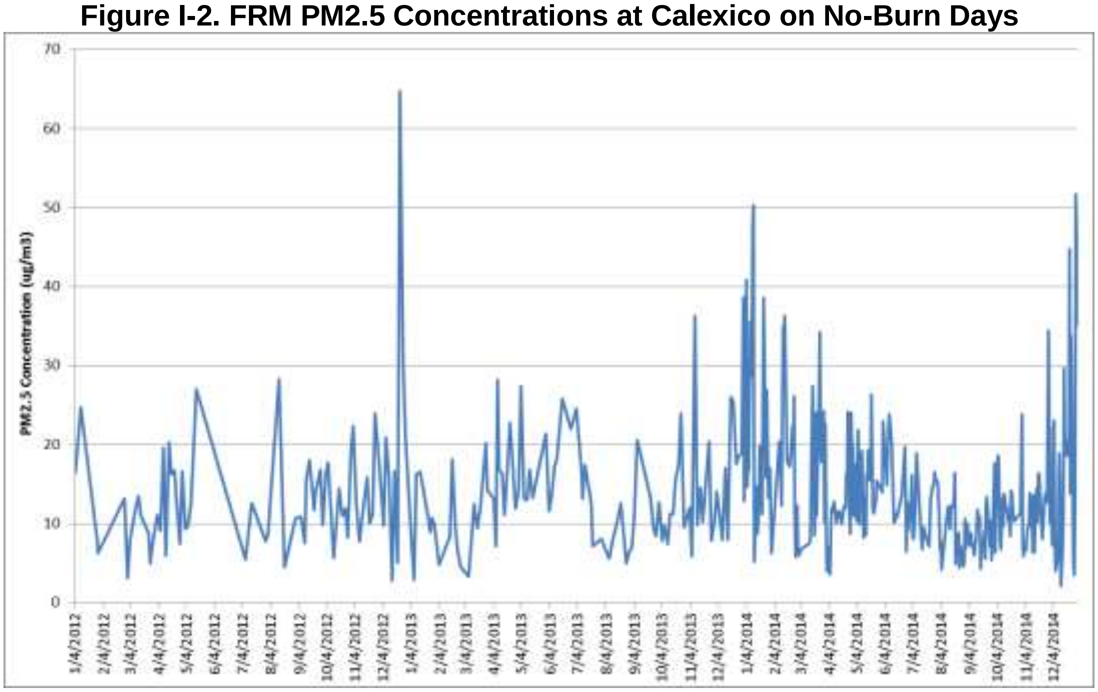


Figure I-2. FRM PM2.5 Concentrations at Calexico on No-Burn Days



The source contribution analysis in Chapter X and Appendix C show that biomass burning was the second largest contributor to PM2.5 concentrations in Calexico. According to this analysis, biomass burning contributed approximately 19 percent of the emissions at Calexico between January 2011 and August 2015. However, these emissions also included biomass emissions from Mexicali, shown to be much higher than the emissions in the Imperial County PM2.5 NA. If all biomass burning were banned in both Imperial County and Mexicali, it is anticipated that the annual PM2.5 design value at Calexico would be lower. However, as documented above, the District's agricultural burn program effectively limits burning on forecasted high PM2.5 days.

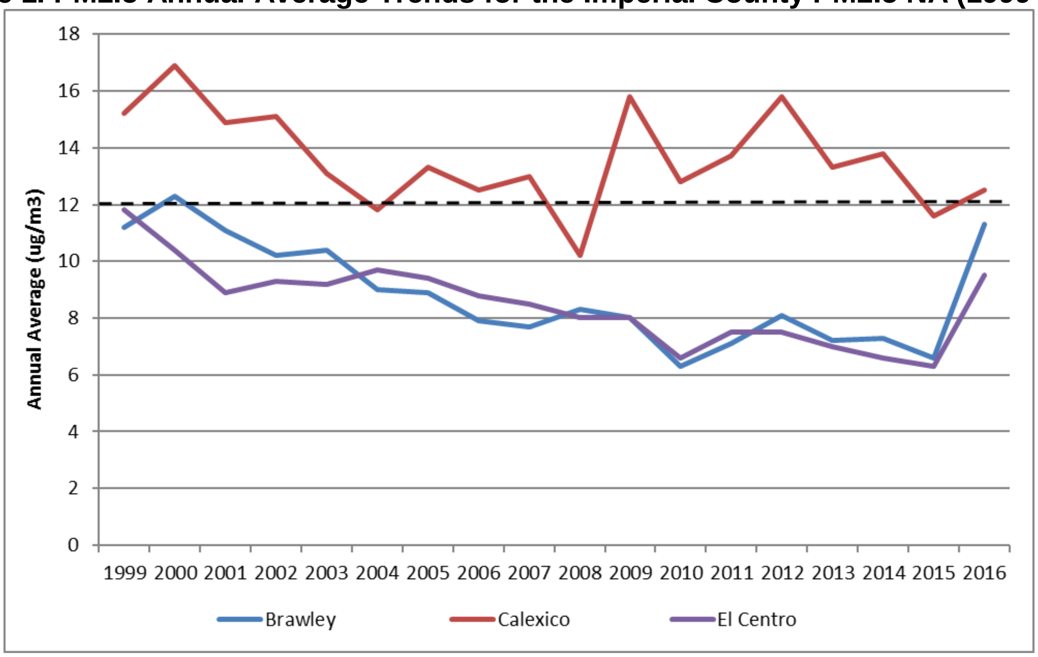
Appendix J: Recent PM2.5 Data and Trends

I. Imperial County PM2.5 NA Air Quality

A. Design Values (DVs)

The trend in the annual average PM2.5 at Calexico has improved significantly over the past few years. In 2014, the annual average at the Calexico monitor was 13.8 ug/m3. In 2016, the annual average at Calexico decreased 10 percent to 12.5 ug/m3. Although El Centro and Brawley annual averages did increase in 2016, they are still under the level of the annual standard. Analysis provided by CARB indicates that Calexico's high PM2.5 levels occur mostly in the winter when winds are stagnant and PM2.5 pollution increases. Figure 1 below shows the PM2.5 annual average trend for the three stations located within the Imperial County PM2.5 NA from 1999-2016.

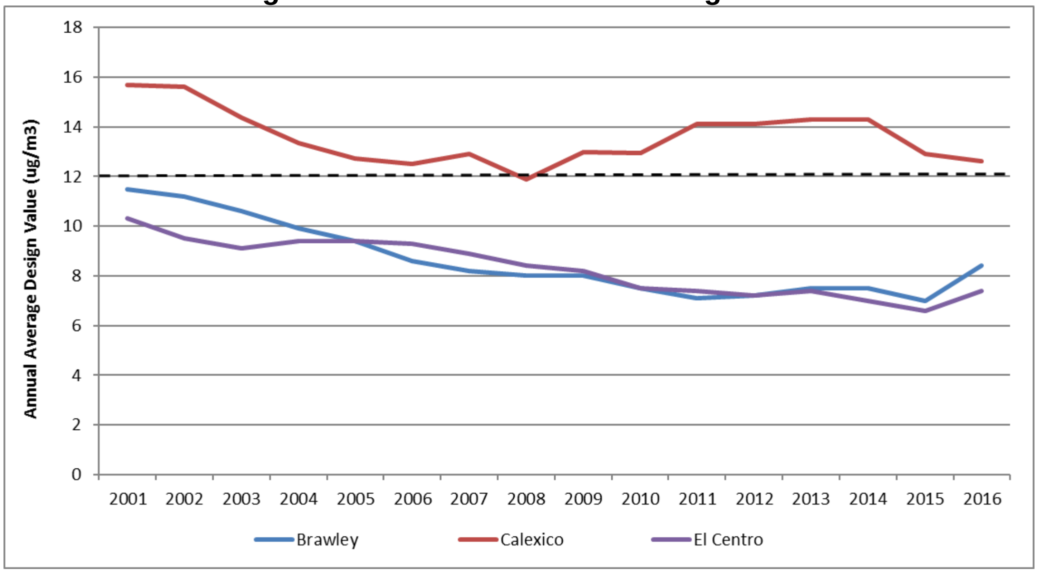
Figure 1. PM2.5 Annual Average Trends for the Imperial County PM2.5 NA (1999-2016)



*2008, 2009, 2011, and 2012 annual average data were incomplete at Calexico.
** The annual average for 2015 shown above is 11.6 ug/m3 and does not include data from the Special Purpose Monitor (SPM) at Calexico. AQS includes data from the SPM in quarters 1 and 4, which results in an annual average of 12.2 ug/m3.

Figure 2 below demonstrates that the Imperial County PM2.5 NA is nearing the level of the annual standard and exceeds the annual PM2.5 standard by 5 percent.

Figure 2. 2001-2016 Annual Average DVs

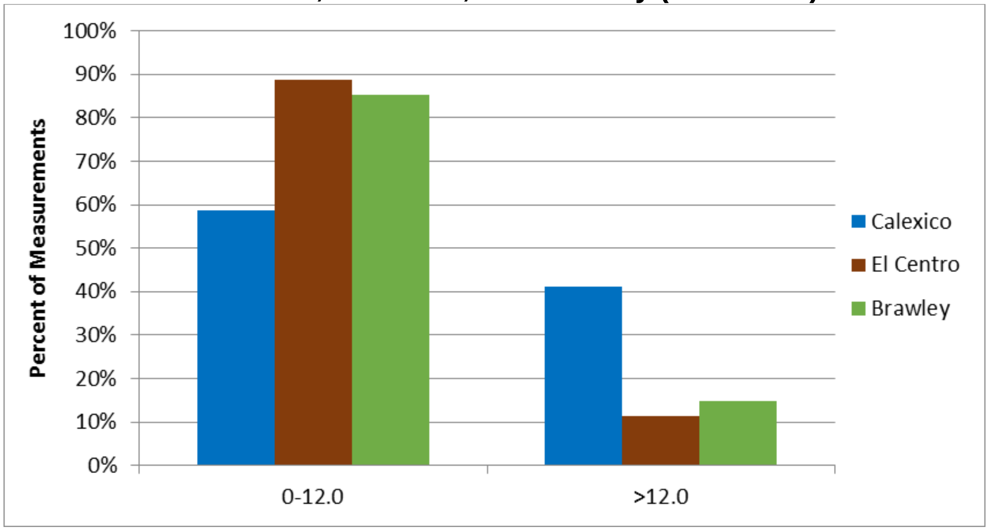


* The 2015 design value shown above is 12.9 ug/m3 and does not include data from the SPM that was included in 2015 at Calexico. AQS includes data from the SPM in quarters 1 and 4 of 2015, which results in a design value of 13.1 ug/m3.

To better assess PM2.5 air quality in the Imperial County PM2.5 NA over multiple years, daily PM2.5 concentration values recorded at Calexico, El Centro, and Brawley between 2014 and 2016 were analyzed in relation to the 12.0 µg/m^3 PM2.5 standard. The histogram in Figure 3 categorizes PM2.5 data measured at the three Imperial County PM2.5 NA sites between 2014 and 2016 into two bins with the upper end value of the first bin equal to the level of the annual PM2.5 standard. The data show the percentage of measurements with concentrations within the annual PM2.5 standard range and above the annual standard. Between 2014 and 2016, more than 40 percent of the PM2.5 concentrations recorded at the Calexico monitoring site were over the annual standard of 12.0 µg/m^3, while El Centro and Brawley experienced days over 12.0 µg/m^3 on approximately 10 percent of the days.

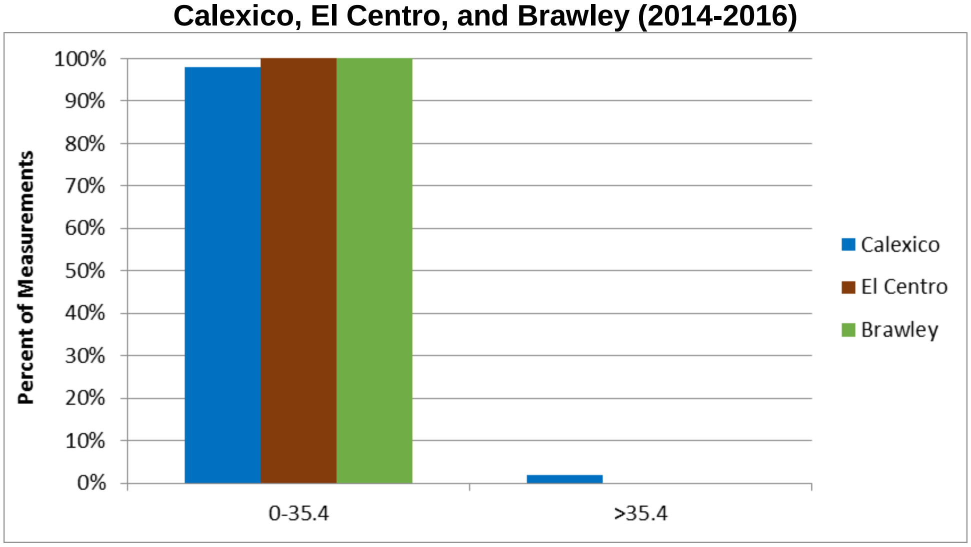
The data indicate that PM2.5 concentrations measured at Calexico are above the annual standard at a higher frequency than other PM2.5 sites in the Imperial County PM2.5 NA. The El Centro and Brawley sites show a similar pattern with the majority of samples collected reflecting measured PM2.5 values equal to or below the annual standard. While the cause for this difference is not evident from these data alone, the pattern suggests emission activities influencing Calexico are not regularly impacting monitoring sites farther to the north.

Figure 3. Percentage of PM2.5 Values Relative to the Annual Standard: Calexico, El Centro, and Brawley (2014-2016)



A similar plot of PM2.5 concentrations above the 35 µg/m^3 24-hour standard indicates that a greater number of values over the 24-hour standard occurred at the Calexico site than at either of the other sites (Figure 4). Because the annual standard is lower than the 24-hour standard, more values over 12.0 µg/m^3 recorded at each site are expected. The larger difference between the percentages of values above the annual standard recorded at Calexico and sites farther from the border versus those differences associated with the 24-hour standard suggests that Calexico is experiencing a year-round influence of cross-border emissions resulting in exceedances of the annual standard.

Figure 4. Percentage of PM2.5 Values Relative to the 24-Hour Standard: Calexico, El Centro, and Brawley (2014-2016)



To evaluate the temporal distribution of PM2.5 concentrations above the standard, data plots were constructed using the average monthly concentration measured at Calexico, El Centro, and Brawley from 2014 through 2016 (Figure 5). In addition, time series plots were developed using the coincident PM2.5 concentration data collected at Calexico, El Centro, and Brawley from 2014 through 2016 (Figure 6). For both data sets only PM2.5 FRM data were used for comparison purposes. Similar to the temporal pattern observed in the analysis conducted for the 24-hour plan,[1] the majority of days with higher PM2.5 concentrations at Calexico occur during the winter months.

Figure 5. Average PM2.5 FRM Concentration by Month from Monitoring Sites in Calexico, El Centro, and Brawley (2014 - 2016)

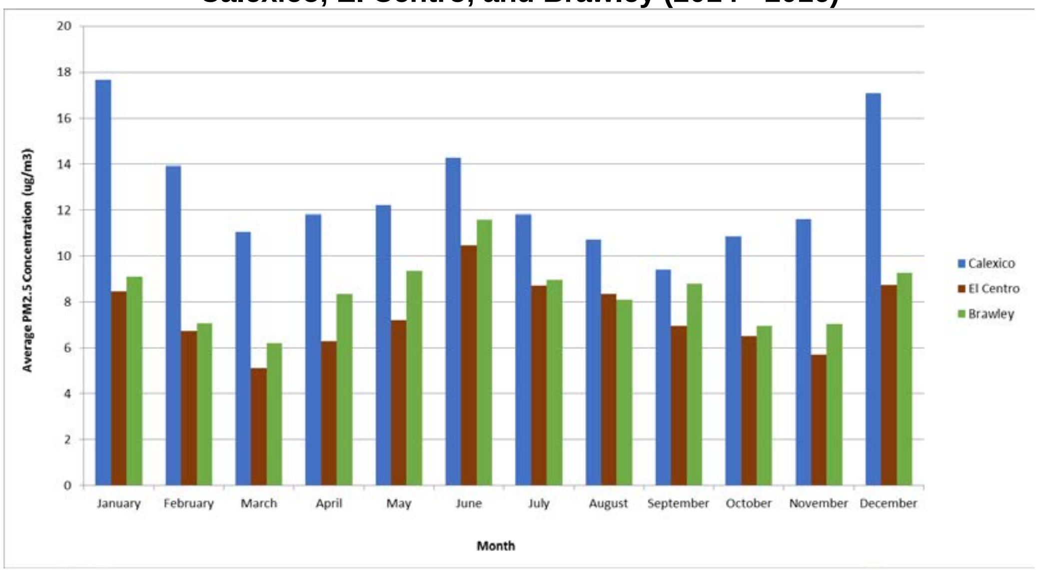
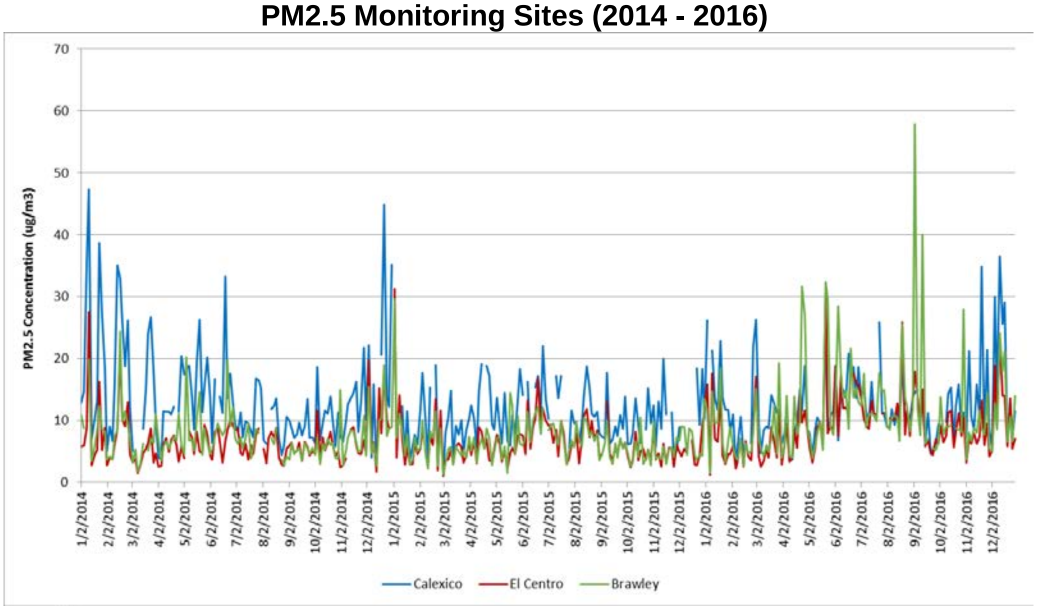


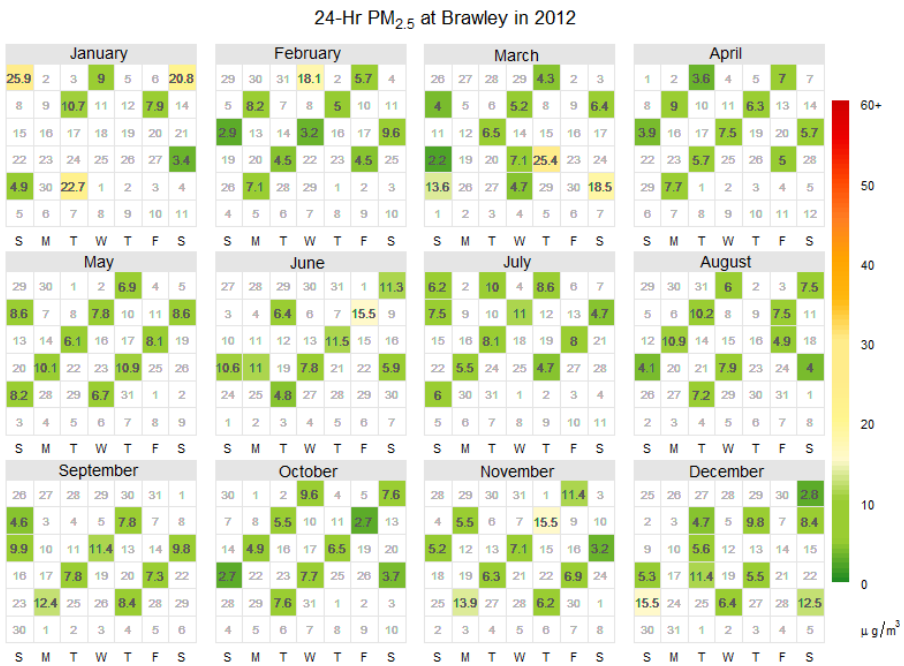
Figure 6. Coincident PM2.5 FRM Values at Imperial County PM2.5 Monitoring Sites (2014 - 2016)

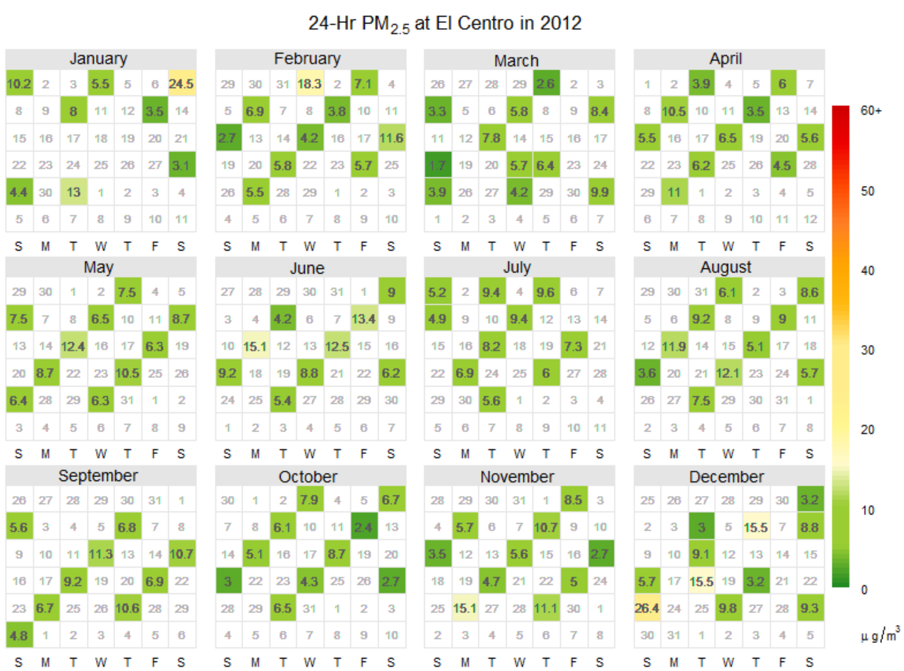


[1] California Air Resources Board, Staff Report: Imperial County 2013 State Implementation Plan for the 2006 24-hour PM2.5 Moderate Nonattainment Area; December 8, 2014 release date.

Figures 7-11 show the daily PM2.5 concentrations at Brawley, El Centro, and Calexico during 2012-2016. The color scale at the right of each plot corresponds to the level of PM2.5 concentrations. In 2014, Calexico started recording daily PM2.5 data so the frequency of samples increased. These plots indicate that on average, Calexico records the majority of the high PM2.5 concentrations in the Imperial County PM2.5 NA, typically in the winter months.

Figure 7. 2012 PM2.5 Concentrations (monitors listed from north to south)





24-Hr $PM_{2.5}$ at Calexico in 2012

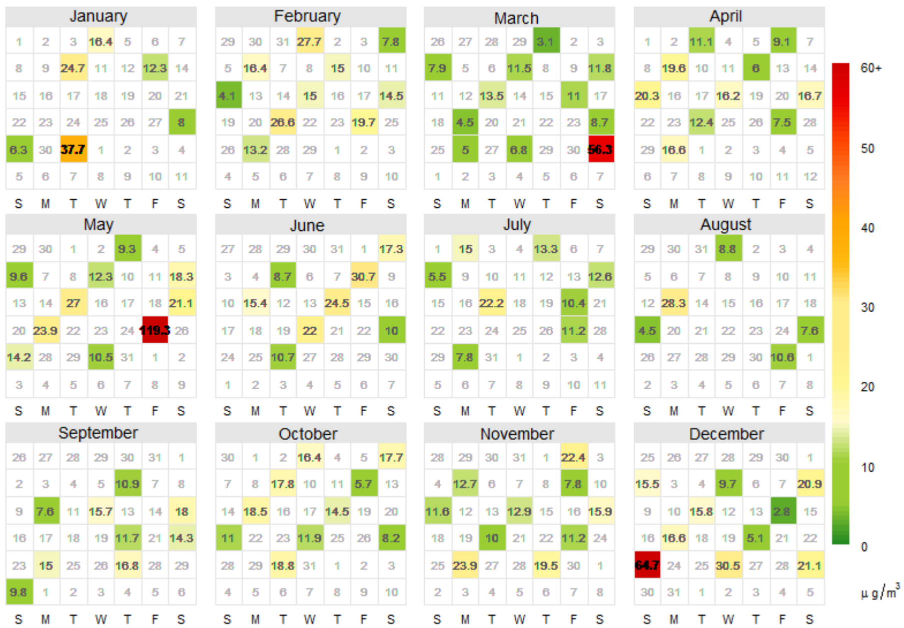
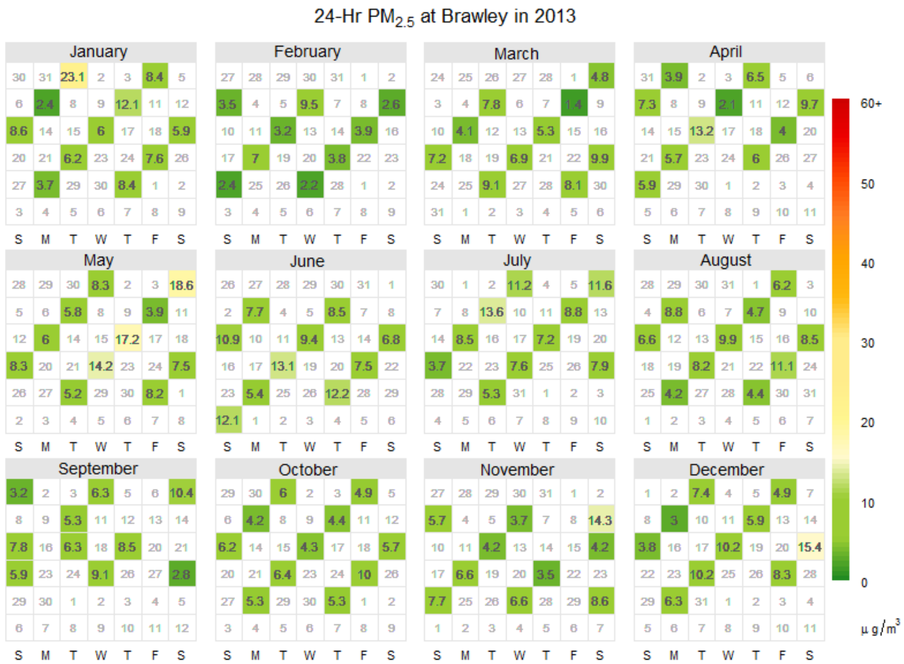
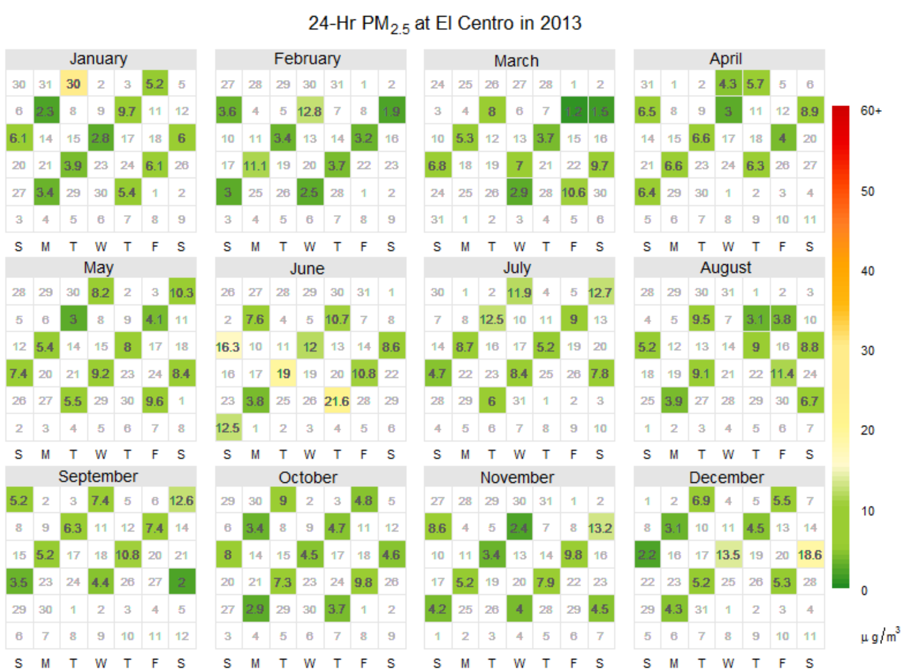


Figure 8. 2013 PM2.5 Concentrations (Monitors listed from North to South)





24-Hr $PM_{2.5}$ at Calexico in 2013

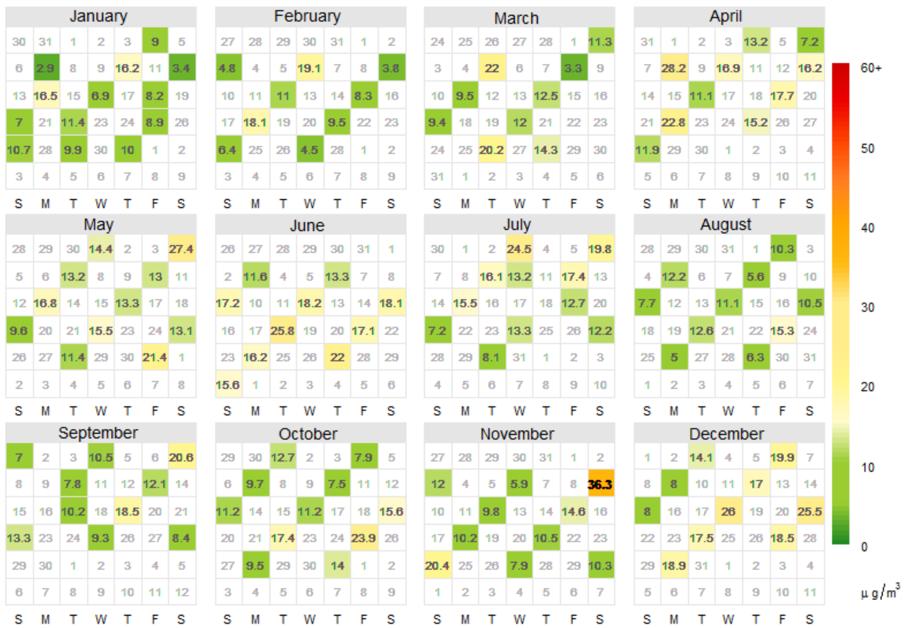
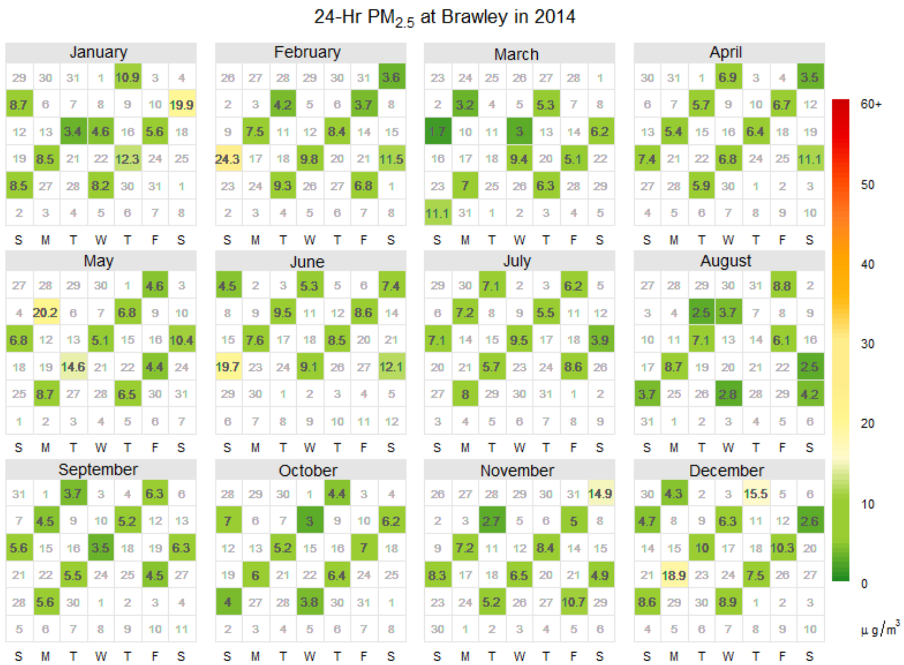
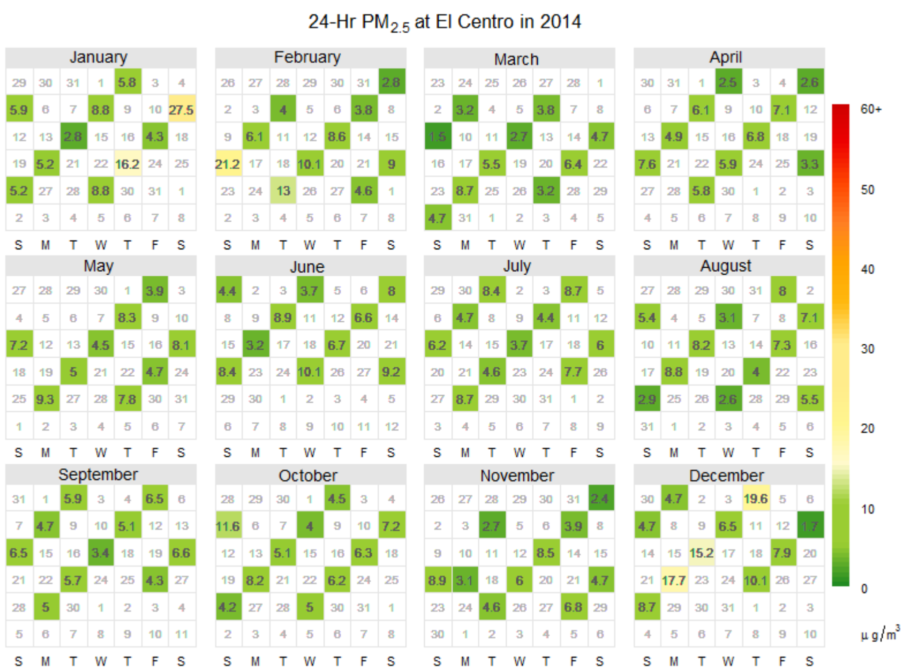


Figure 9. 2014 PM2.5 Concentrations (Monitors listed from North to South)





24-Hr $PM_{2.5}$ at Calexico in 2014

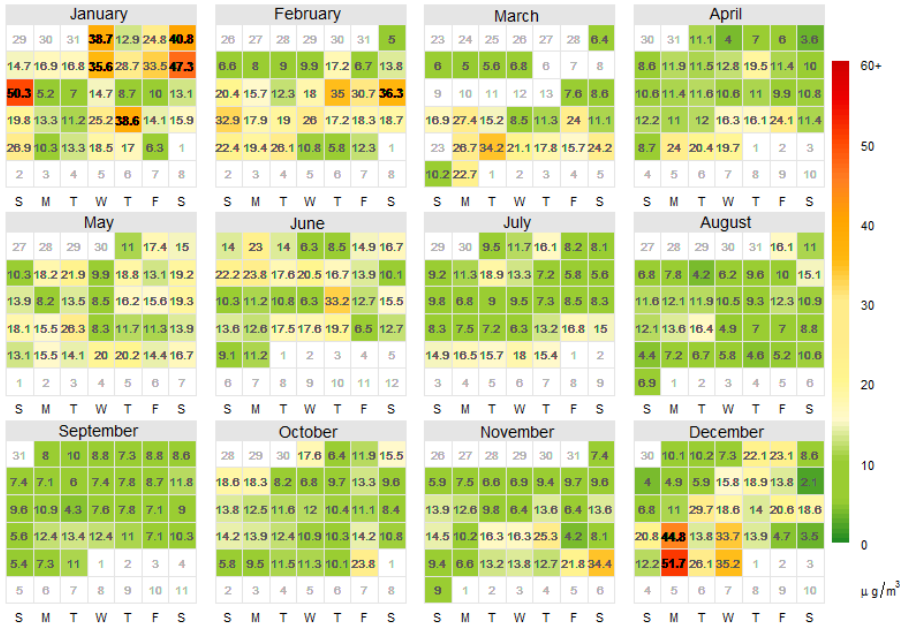
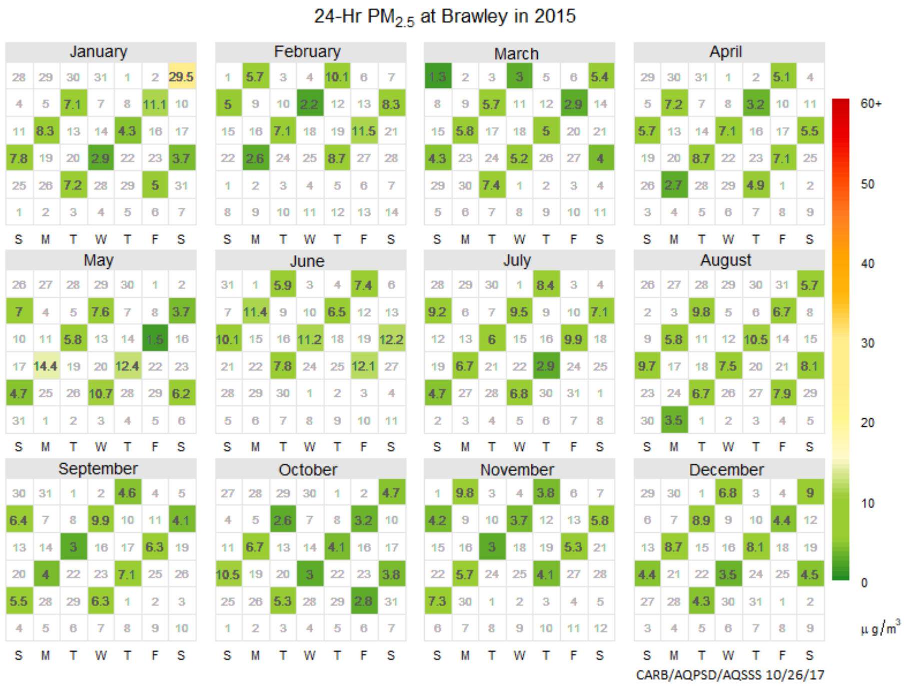
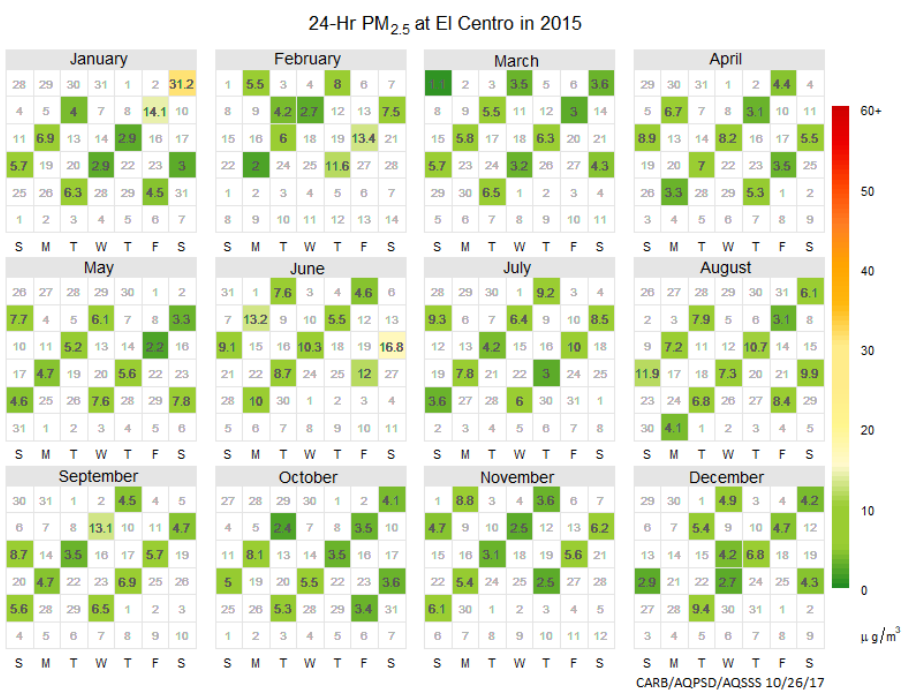


Figure 10. 2015 PM2.5 Concentrations (Monitors listed from North to South)





24-Hr $PM_{2.5}$ at Calexico in 2015

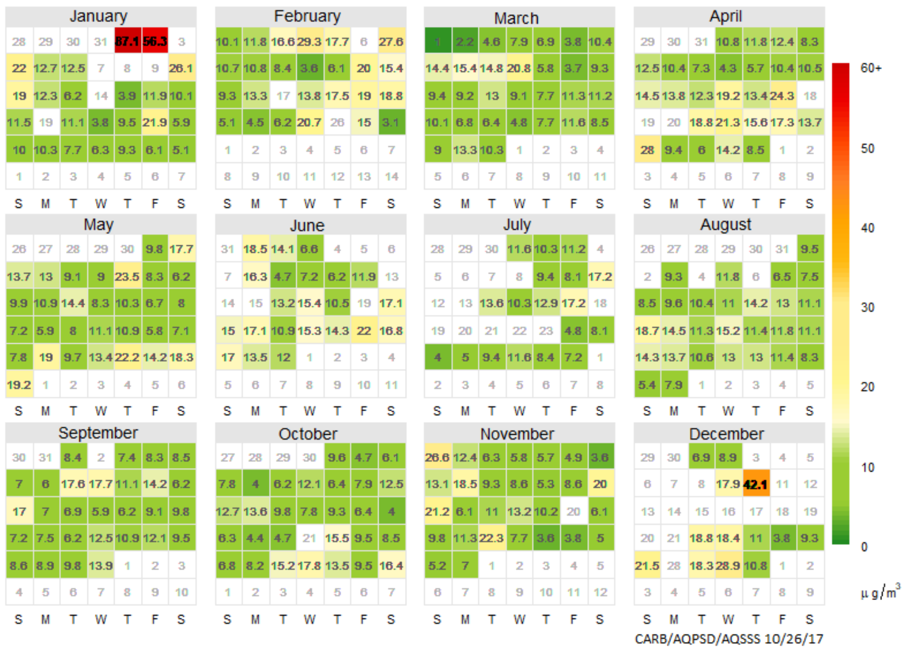
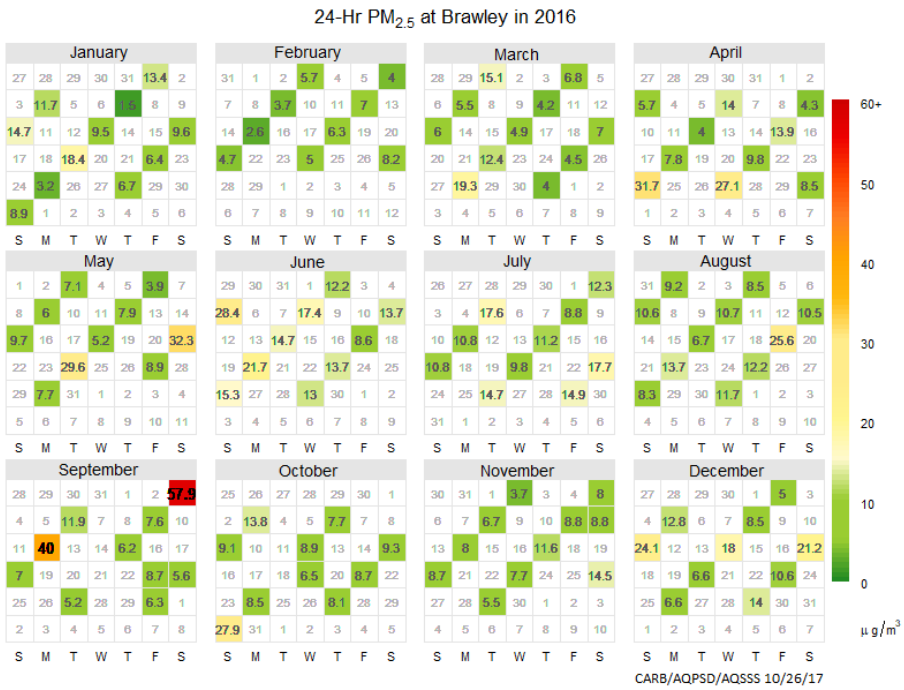
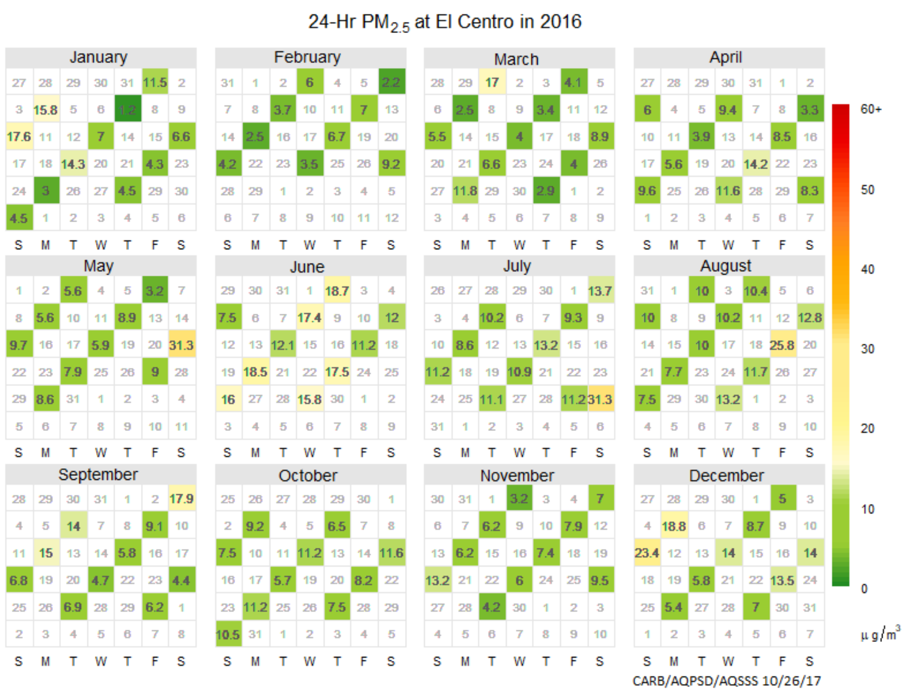
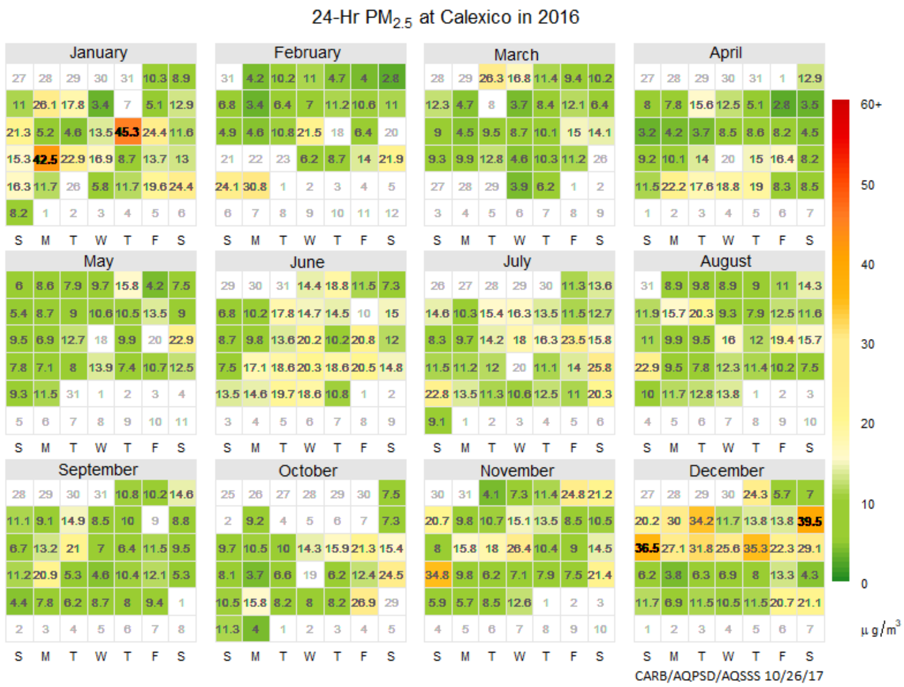


Figure 11. 2016 PM2.5 Concentrations (Monitors listed from North to South)







II. Meteorology Impact

Section VII of the 179B Technical Demonstration was repeated below using 2014-2016 meteorology and air quality data. This analysis helps to determine if the previous analysis which showed high PM2.5 when the winds are from the south remains consistent with more recent data.

A. Wind Direction

Monthly wind rose plots were made of the hourly average wind data in Calexico from 2014 through 2016 (Figure 12). The predominant wind patterns in the border region are from the northwest in the winter and southeast in the summer. Under stagnant conditions, pollutants within the Calexico-Mexicali air shed will tend to accumulate and exceedances will occur with greater frequency. As discussed later in this section the greatest number of low wind speed episodes occur October through February. As shown in Figure 7, calm wind (wind speed less than 1 m/s) occurs the most in January (39.9%) and the least in June (12.2%).

Figure 12. Calexico Wind Rose Plots (2014-2016)

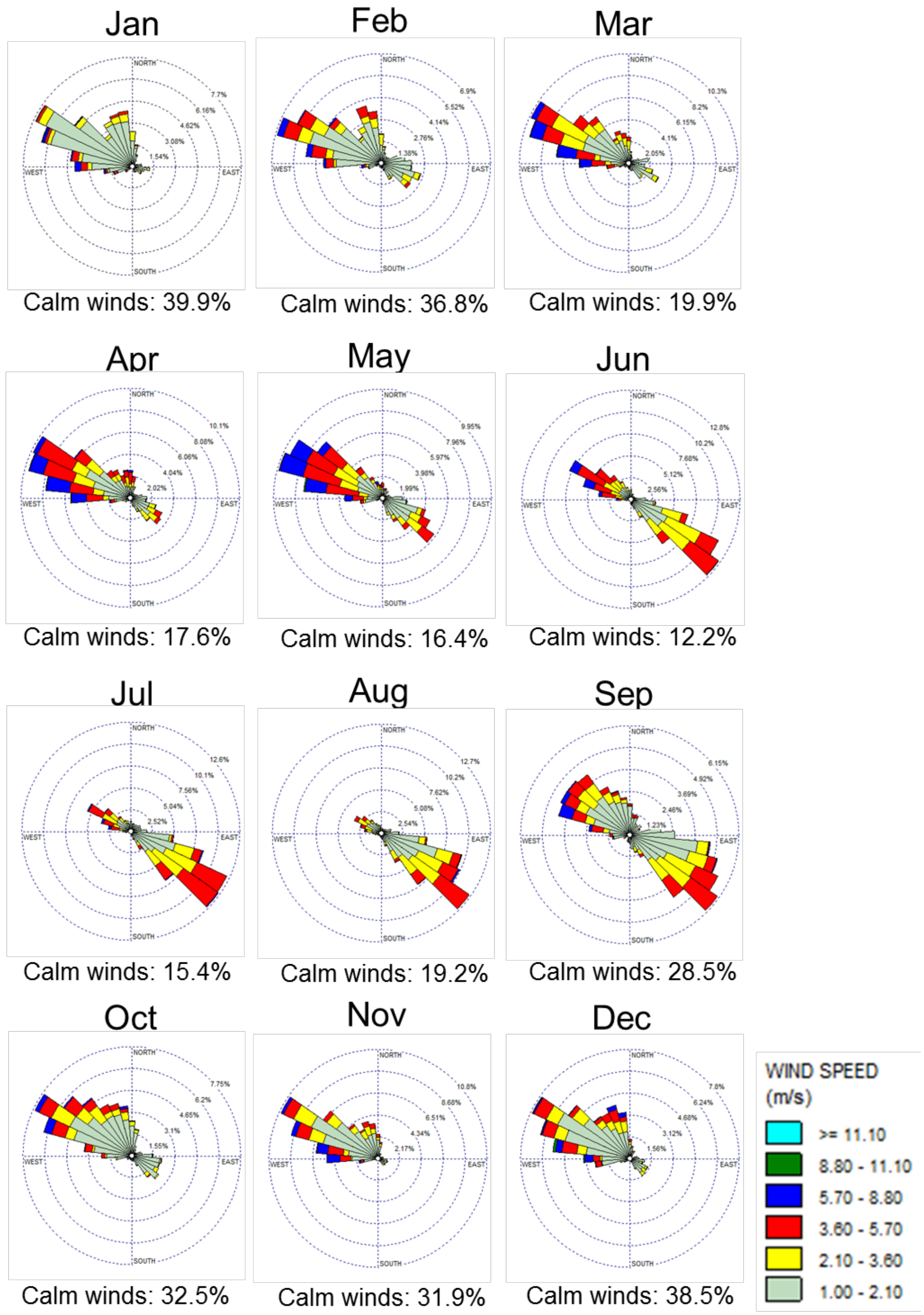
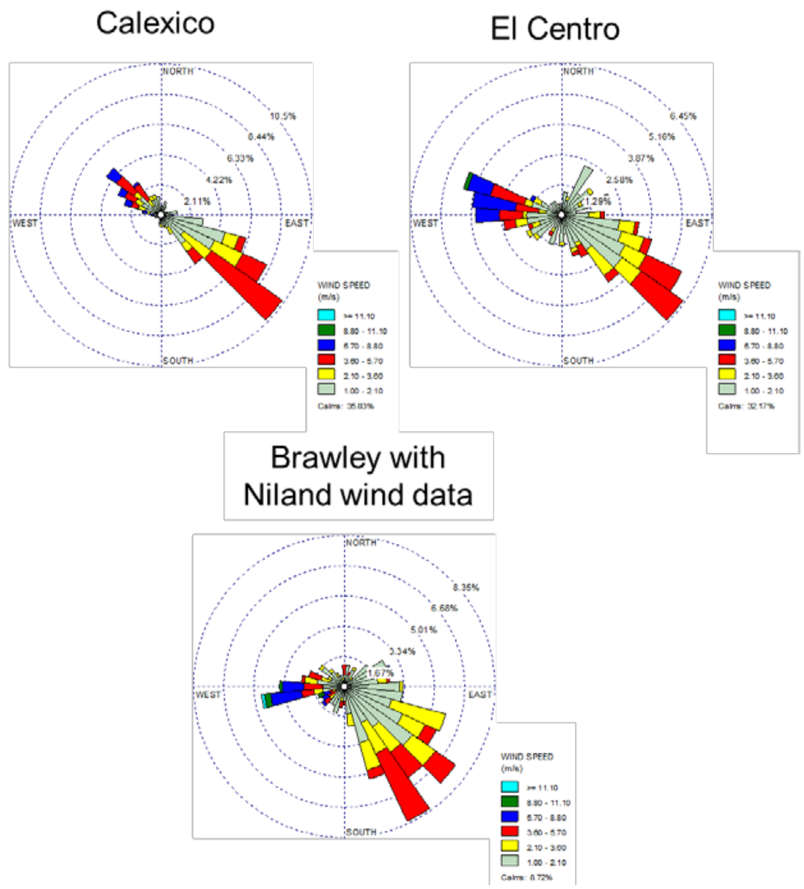


Figure 13 displays the wind roses for each of the three monitoring sites on days when all sites exceeded the level of the annual standard in 2014-2016. These plots indicate that all of the PM2.5 sites in the Imperial County PM2.5 NA are impacted when the winds are generally from the southeast. The frequency of calm winds, indicative of stagnant conditions, occurs more at Calexico (36%) and El Centro (32%) than at the more northern Brawley site (9%). Meteorological data are not available from the Brawley monitoring site so data from Westmorland were used as a proxy for wind speed and direction at the site.

Figure 13. Average Wind Rose on Days above 12 $\mu g/m^3$ (2014-2016)



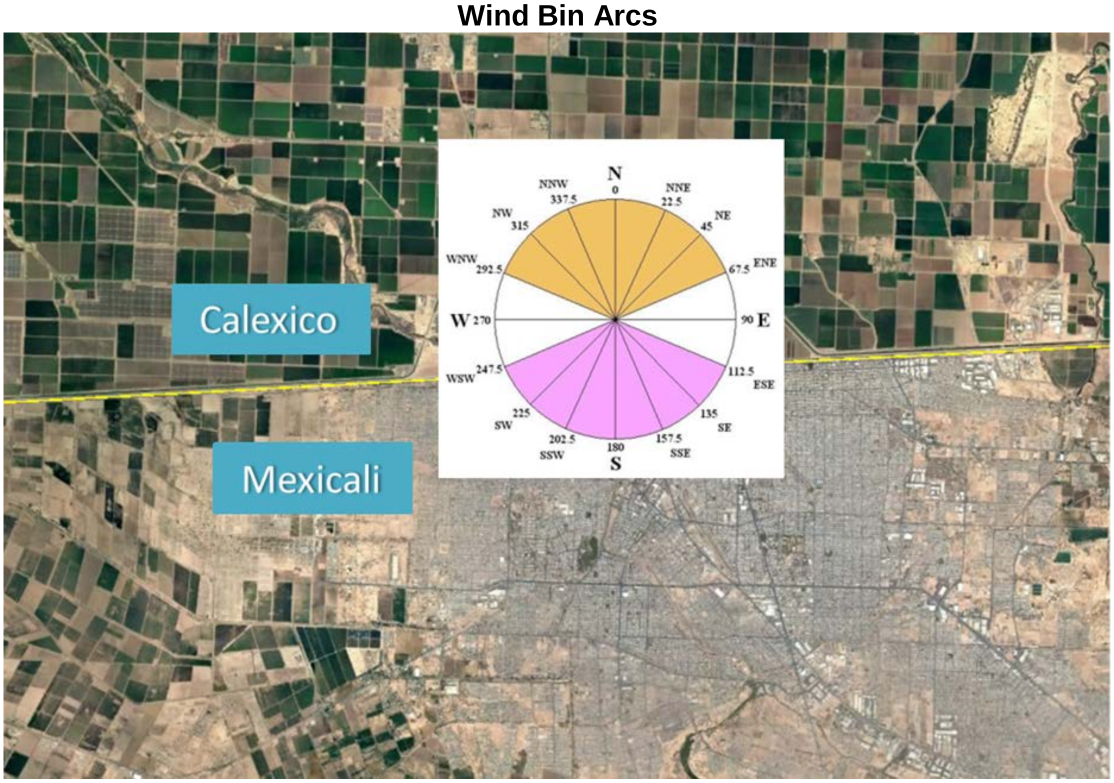
B. PM2.5 Impact by Wind Direction

To assess the extent to which wind direction may affect pollutant transport, hourly Beta-Attenuation Monitor (BAM)[2] PM2.5 measurements were binned by wind direction for all hours in 2014 through 2016. For this analysis, wind direction bins were established by dividing the compass into sixteen equal sized arcs, starting at due north. In order to evaluate the PM2.5 impact from each wind direction, hourly data must be used; therefore, hourly PM2.5 concentrations recorded by the primary BAM monitor at the Calexico station from 2014 through 2016 were assigned to a wind direction bin. Although BAMs generally record higher PM2.5 concentrations than the FRMs, they provide useful information to evaluate the relative impact of emissions at the monitor. The averages of PM2.5 concentrations within each bin were then calculated and tabulated together with the number of hours of data in each bin.

[2] PM2.5 BAM unit located at Calexico monitoring station (POC3).

The wind direction arcs are shaded to represent three separate upwind source areas (Figure 14). Segments ranging from 292.6 to 67.5 degrees, and crossing due north, designate winds blowing from the north (northern orange arc), transporting emissions only from Imperial County sources to the monitor. Segments ranging from 112.6 to 247.5 degrees include winds blowing from the south (southern pink arc), transporting emissions to the monitor from sources in Mexicali and in the narrow area of Calexico between the monitor and the border. Segments extending from 67.6 to 112.5 degrees and from 247.6 to 292.5 degrees bracket wind directions that transport mixtures of Calexico and Mexicali source contributions to the monitor. The data from these segments are not further evaluated in this analysis because of the uncertainty in origin of emissions transported from these directions. Assuming that winds from the northern arc transport emissions exclusively from sources within the Imperial County PM2.5 NA to the Calexico monitor, the relative impact of local sources on the monitor may be compared with PM2.5 concentrations from the other directions.

Figure 14. Compass Display of the Northern (orange) and Southern (pink) Wind Bin Arcs



PM2.5 average concentrations related to winds from the south were substantially higher than concentrations related to winds from the north (Table 1). Although winds occur more frequently from the north, the PM2.5 concentrations from within this sector range from an average of 10.3 to 14.7 µg/m^3, while concentrations within the southern sector range from an average of 16.3 to 23.3 µg/m^3. To determine the impact of each wind segment on the 2016 DV at the Calexico monitor, an index was created by multiplying the average PM2.5 concentration by the number of wind hours in each segment in 2014-2016. This index provided a means to evaluate the “PM2.5 exposure” in µg/m^3

from each wind direction segment. The exposure index for each wind direction was then divided by the total index for all wind segments to obtain a “PM2.5 Exposure Fraction.” The last column in Table 1 shows the corresponding contribution in µg/m^3 to the DV of 12.6 µg/m^3 in 2016 for each wind direction bin.

Table 1. Calexico BAM Average PM2.5 DV Comparison by Wind Direction (WD) Bin

Degrees	Average BAM PM2.5 Concentration by WD	Count of Wind Hours in Segment	% of Hours from WD	PM2.5 Exposure Index (Avg PM2.5 *Hours)	PM2.5 Exposure Fraction (Index by WD/Total)	Wind Segment Contribution to DV of 12.6
0-22.5	11.9	993	4%	11850	3%	0.4
22.6-45	14.0	703	3%	9849	3%	0.4
45.1-67.5	14.7	803	3%	11791	3%	0.4
67.6-90	16.0	1224	5%	19527	6%	0.7
90.1-112.5	16.4	2134	9%	34949	10%	1.3
112.6-135	16.3	3159	13%	51536	15%	1.9
135.1-157.5	17.7	1495	6%	26454	8%	1.0
157.6-180	20.9	522	2%	10925	3%	0.4
180.1-202.5	23.3	353	1%	8212	2%	0.3
202.6-225	22.1	359	1%	7949	2%	0.3
225.1-247.5	20.0	501	2%	10035	3%	0.4
247.6-270	16.1	1262	5%	20267	6%	0.7
270.1-292.5	12.5	3324	13%	41550	12%	1.5
292.6-315	11.0	4026	16%	44325	13%	1.6
315.1-337.5	10.9	2062	8%	22510	6%	0.8
337.6-360	10.3	1726	7%	17771	5%	0.6
Total		**24646**	**100%**	**349500**	**100%**	**12.6**

This analysis shows that even though south winds occurred only 25 percent of the time in 2014-2016, their associated PM2.5 contribution to the Calexico DV was 4.3 µg/m^3. This strongly indicates that if southern winds and the corresponding Mexicali emissions were not impacting the Calexico monitor, the site would be in attainment of the annual 12.0 µg/m^3 PM2.5 standard.

Hourly PM2.5 concentrations recorded when winds were within each of the two wind direction arcs (north and south) were averaged to distinguish 3-year average concentrations when winds transported only Imperial County emissions to the Calexico monitor (north) versus when winds transported only Mexicali emissions to the monitor (south). The result, as presented in Table 2, indicates that the weighted average PM2.5 concentration when winds are from Mexicali was much higher than the average concentration associated with winds blowing from Imperial County source areas. The weighted average PM2.5 concentration for the hours when the winds were from the north was 11.5 µg/m^3 in 2014-2016. In comparison, the corresponding average when winds were from the south was 18.0 µg/m^3, 57 percent higher.

Table 2. Hourly PM2.5 Average of all North and South Wind Hours at Calexico

Direction	PM2.5	DV	WD
North (292.6-67.5)	11.5	4.3	42%
South (112.6-247.5)	18.0	4.1	26%

Table 3 below repeats the same analysis, using only PM2.5 concentrations recorded when wind speeds exceeded the transport threshold of 1.5 meters per second (m/s). Below this wind speed threshold, Calexico experienced stagnation conditions during which wind directions are variable and below measurement thresholds. The removal of these stagnation periods produces a more representative estimate of emission transport from sources upwind in either direction. The results, as shown in Table 3, exhibit a similar concentration gradient as seen in Table 1 above, with averages increasing as the direction shifts from north to south. Because episodes with very low wind speeds are characterized by higher PM2.5 concentrations, removal of these hours produces lower PM2.5 averages in all wind direction arcs.

Table 3. Calexico BAM Average PM2.5 DV Comparison by Wind Direction (WD) Bin (Winds Over 1.5 m/s)

Degrees	PM2.5 Concentration by WD	Count of Wind Hours in Segment	% of Hours from WD	Exposure Index (Avg PM2.5 *Hours)	PM2.5 Exposure Fraction (Index by WD/Total)	Wind Segment Contribution to DV of 12.6
0-22.5	7.4	256	2%	1890	2%	0.2
22.6-45	8.2	44	0%	362	0%	0.0
45.1-67.5	5.0	4	0%	20	0%	0.0
67.6-90	13.8	26	0%	360	0%	0.0
90.1-112.5	13.2	659	6%	8706	8%	1.0
112.6-135	14.0	2126	20%	29698	26%	3.2
135.1-157.5	14.3	807	8%	11512	10%	1.3
157.6-180	16.4	95	1%	1560	1%	0.2
180.1-202.5	16.5	33	0%	544	0%	0.1
202.6-225	15.4	31	0%	476	0%	0.1
225.1-247.5	6.9	50	0%	344	0%	0.0
247.6-270	9.6	370	3%	3546	3%	0.4
270.1-292.5	10.5	1870	18%	19629	17%	2.1
292.6-315	9.3	2541	24%	23641	20%	2.6
315.1-337.5	8.3	963	9%	8029	7%	0.9
337.6-360	6.7	748	7%	5016	4%	0.5
Total		**10623**	**100%**	**115333**	**100%**	**12.6**

Table 4 shows that the weighted average hourly PM2.5 concentration under northern non-stagnant wind conditions was 8.6 µg/m^3, with winds from these directions occurring 43 percent of the time. In comparison, the weighted average hourly PM2.5 concentration under southern wind conditions was nearly double at 14.0 µg/m^3, with winds occuring only 30 percent of the time. This analysis further demonstrates that if Mexicali emissions were not impacting the Calexico monitor, even under non-stagnant wind speeds, the site would be in attainment of the annual 12.0 µg/m^3 PM2.5 standard.

Table 4. Hourly PM2.5 Average of all Non-Stagnant North and South Wind Hours at Calexico (Winds Over 1.5 m/s)

Direction	Average	Contribution to	% of time from
North (292.6-67.5)	8.6	4.3	43%
South (112.6-247.5)	14.0	4.8	30%

Because the BAM FEM hourly concentrations are not those used in computing the PM2.5 DV for the Imperial County PM2.5 NA, the BAM data were converted into equivalent FRM DV contributions for comparison to the annual standard.
A BAM equivalent DV for the 2014-2016 baseline period was calculated from hourly BAM data using the same quarterly averaging and truncation protocols that are prescribed for computing a DV from 24-hour average FRM data. The intermediate and final values produced by this calculation are presented in Table 5 together with the corresponding values produced by computing the DV from FRM data. The relationship between FRM and BAM average concentrations varies from quarter to quarter in the absence of any obvious trend, but the differences are somewhat small and the 3-year average DVs of 12.6 and 14.2 µg/m^3, respectively, differ by about 13 percent.

Table 5. Calexico FRM and BAM 2014-2016 PM2.5 DVs

Year	Quarter	FRM	BAM
2014	1	18.3	21.3
	2	14.0	17.8
	3	9.4	12.2
	4	13.5	15.7
2015	1	12.5	14.9
	2	12.6	12.1
	3	10.4	10.3
	4	10.9	13.5
2016	1	12.1	13.5
	2	11.6	12.1
	3	12.0	12.5
	4	14.3	14.0
2014 Annual Average		13.8	16.8
2015 Annual Average		11.6	12.7
2016 Annual Average		12.5	13.0
2016 Design Value		12.6	14.2

** The annual average for 2015 shown above is 11.6 ug/m3 and does not include data from the Special Purpose Monitor (SPM) at Calexico. AQS includes data from the SPM in quarters 1 and 4, which results in an annual average of 12.2 ug/m3. If SPM data is included in 2015, the quarterly, annual, and design values would differ from the data in the table above.

The ratio of FRM to BAM 3-year Average DVs (0.887) was applied to the wind direction arc BAM average PM2.5 concentrations in Table 1 to derive equivalent FRM PM2.5 average concentrations for the same wind direction arcs. The results of this conversion are shown in Table 6.

The equivalent FRM PM2.5 average concentrations show that winds approaching the Calexico monitor from the north are characterized by substantially cleaner air quality than winds from the south. When the FRM-equivalent PM2.5 concentrations from all hours in 2014-2016 with north winds are averaged together, the result, 10.8 µg/m^3, is below the level of the annual PM2.5 standard. By comparison, the corresponding average with winds from the south is 17.8 µg/m^3, a level 48 percent higher than the annual standard.

Table 6. Calexico 2014-2016 PM2.5 Equivalent FRM Average Concentrations by Wind Direction Arc

Wind Direction Arc (degrees)	Average BAM PM2.5 by Wind Direction Arc	Average Equivalent FRM PM2.5 by Wind Direction Arc
0-22.5	11.9	10.6
22.6-45	14.0	12.4
45.1-67.5	14.7	13.0
67.6-90	16.0	14.2
90.1-112.5	16.4	14.5
112.6-135	16.3	14.5
135.1-157.5	17.7	15.7
157.6-180	20.9	18.6
180.1-202.5	23.3	20.6
202.6-225	22.1	19.6
225.1-247.5	20.0	17.8
247.6-270	16.1	14.2
270.1-292.5	12.5	11.1
292.6-315	11.0	9.8
315.1-337.5	10.9	9.7
337.6-360	10.3	9.1
Average All WD (2012-14)	14.2	12.6
Wind Direction Arc (degrees)	**Average BAM PM2.5 by Wind Direction**	**Average FRM PM2.5 by Wind Direction**
North (292.6-67.5)	12.1	10.8
South (112.6-247.5)	20.1	17.8

C. Wind Speed

It is clear that wind direction has a great impact on PM2.5 concentrations at the Calexico site. However, wind speed is another important factor to consider when assessing the PM2.5 concentrations experienced at the Calexico site. The relationship between wind speed and BAM PM2.5 concentrations was evaluated by plotting the 2014-2016 daily average BAM measurements with the daily average resultant wind speed data at the Calexico monitor. Figure 15 illustrates a reverse correlation, indicating PM2.5 concentrations increase as wind speed decreases.

Figure 15. Calexico 24-Hour Average PM2.5 Concentrations and Wind Speed (2014-2016)

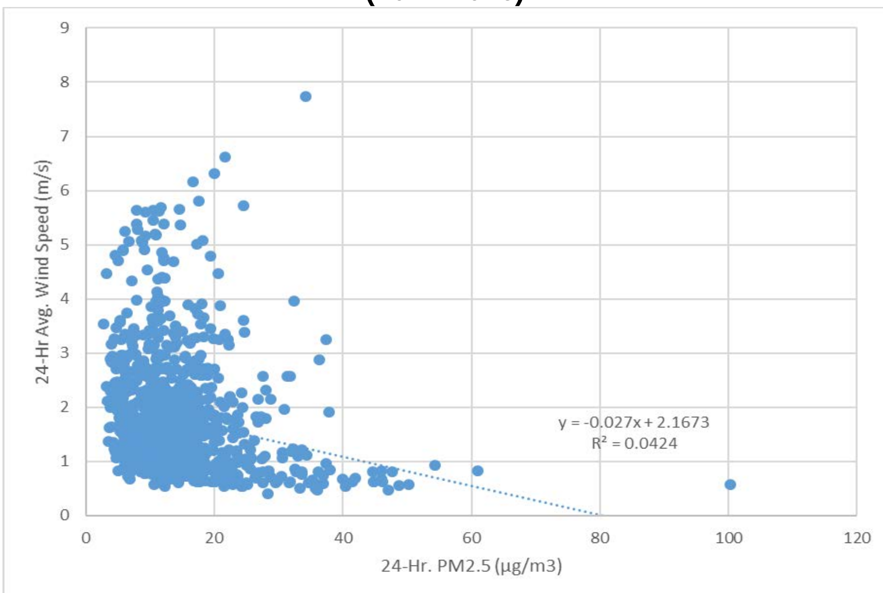
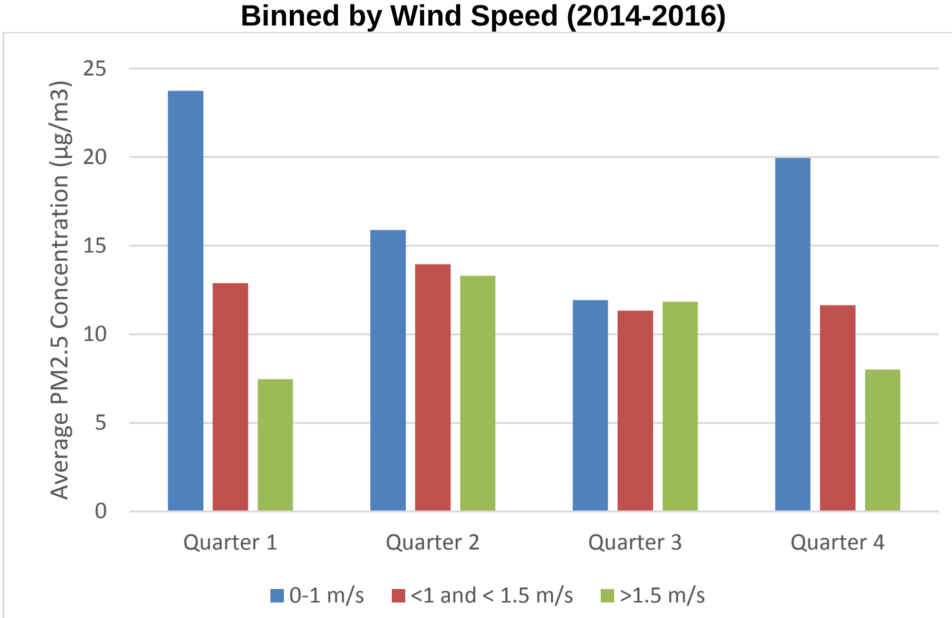


Figure 16 shows the average hourly PM2.5 concentration at Calexico for each quarter from 2014 through 2016, based on binned wind speed. PM2.5 concentrations are highest under stagnant conditions and during the first and fourth quarters of the year. During these quarters, there are periods of increased concentrations at the Calexico monitor due to pollutants accumulating under stagnant meteorological conditions; when higher wind speeds occur, they help to disperse pollutant buildup, resulting in a subsequent concentration decrease. For all four quarters, the highest PM2.5 concentrations occur under very low wind speed conditions.

Figure 16. Average Hourly PM2.5 Concentrations for Each Calendar Quarter Binned by Wind Speed (2014-2016)

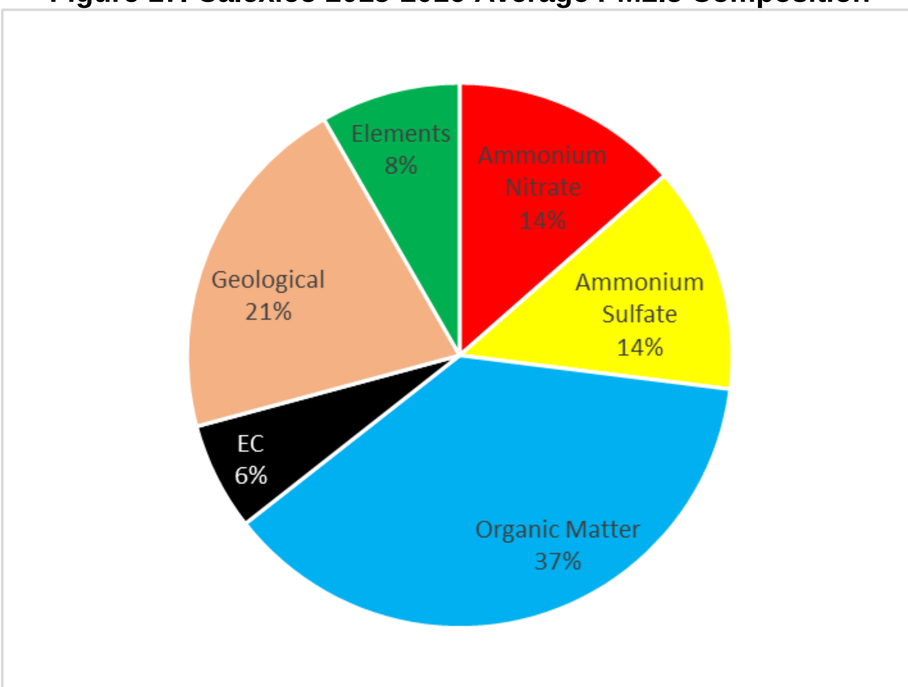


III. Analysis of Calexico Filters

Of the three PM2.5 monitoring sites in the Imperial County PM2.5 NA, the Calexico site is the only current monitoring location with instrumentation capable of collecting samples for chemical speciation. Calexico speciation data were evaluated for the presence of specific elements that would assist in identifying particular emission sources. Based on available data from 2015 through 2016, compositional analysis shows that PM2.5 at Calexico is primarily organic matter followed by geological material.

Figure 17 shows the average PM2.5 composition at Calexico from 2015 through 2016. This data was scaled to the 2014 modeling DV (average of 2012, 2013, and 2014 DVs). Sample analysis indicates that the particulate matter is comprised primarily of carbonaceous aerosols (organic matter (OM) plus elemental carbon (EC)), which make up 43 percent of the PM2.5 mass on average between 2015 and 2016. Carbonaceous aerosols peak in the wintertime, but remain relatively constant throughout the remainder of the year (Figure 18). Much of the carbonaceous aerosol particles originate from combustion sources (burning, tailpipe emissions, etc.).

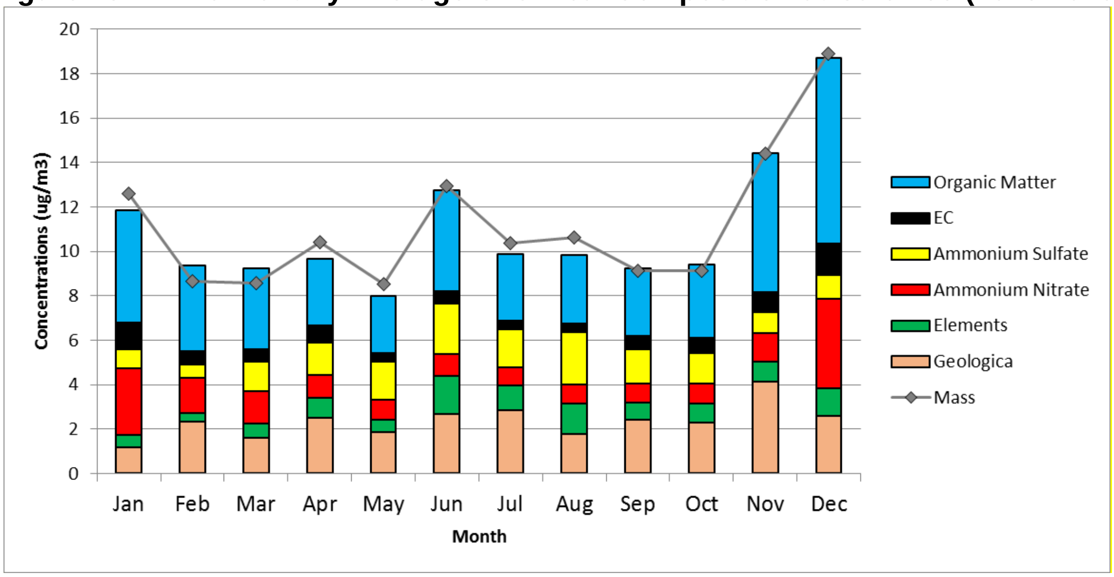
Figure 17. Calexico 2015-2016 Average PM2.5 Composition



Ammonium nitrate and ammonium sulfate also contribute a substantial portion of the measured PM2.5 at Calexico. Ammonium nitrate in particular is formed from the reaction of ammonia and nitric acid. This reaction is higher in the wintertime due to cooler temperatures and higher humidity, which are conducive to a series of complex reactions involving NOx, ammonia, and ROG. Ammonium sulfate is highest during the summer months and is the product of a reaction involving ammonia and sulfuric acid.

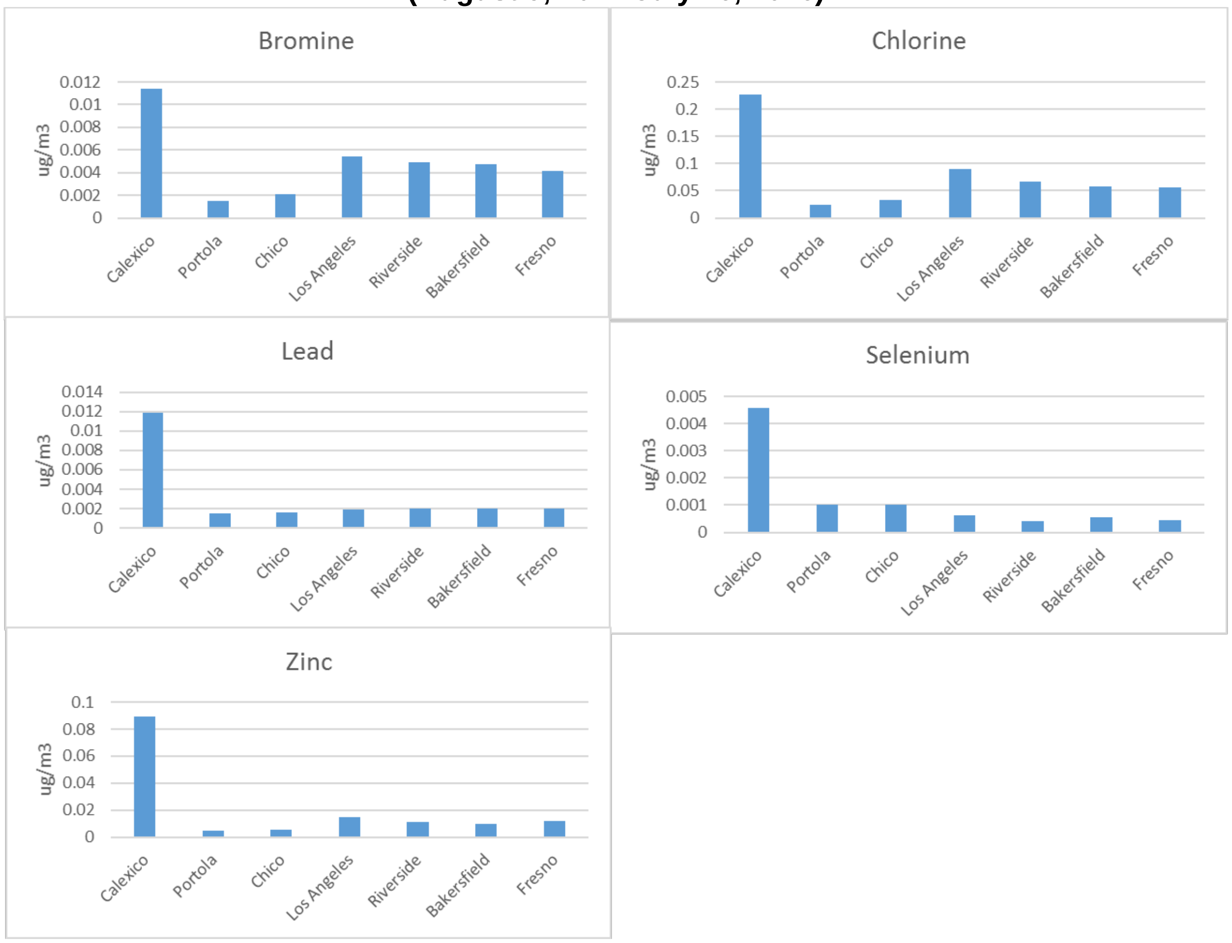
Figure 18 illustrates the seasonal pattern in PM2.5 mass and its components at the Calexico site with the highest concentrations occurring during the winter months, mainly due to increases in organic matter, elemental carbon, and ammonium nitrate. Geological dust is the second highest contributor to PM2.5 at Calexico and is largely due to the surrounding large expanses of desert and arid regions in the air shed. The geological component remains fairly constant throughout the months, with slight increases in the summer and early winter months.

Figure 18. PM2.5 Monthly Average Chemical Composition at Calexico (2015-2016)



Staff compared Calexico speciation data to other locations in the State and noted both similarities and differences in the profiles. Figure 19 compares bromine, chlorine, lead, selenium, and zinc to other sites in California from data collected between August 9, 2014 and July 26, 2016. These elemental components measured two to twenty-two times higher at Calexico than at other sites in California. Concentrations of these elements are low throughout California due to strict environmental controls on industry, the transportation sector, and waste disposal.

Figure 19. Average Concentrations of Select Elemental Species (August 9, 2014-July 26, 2016)

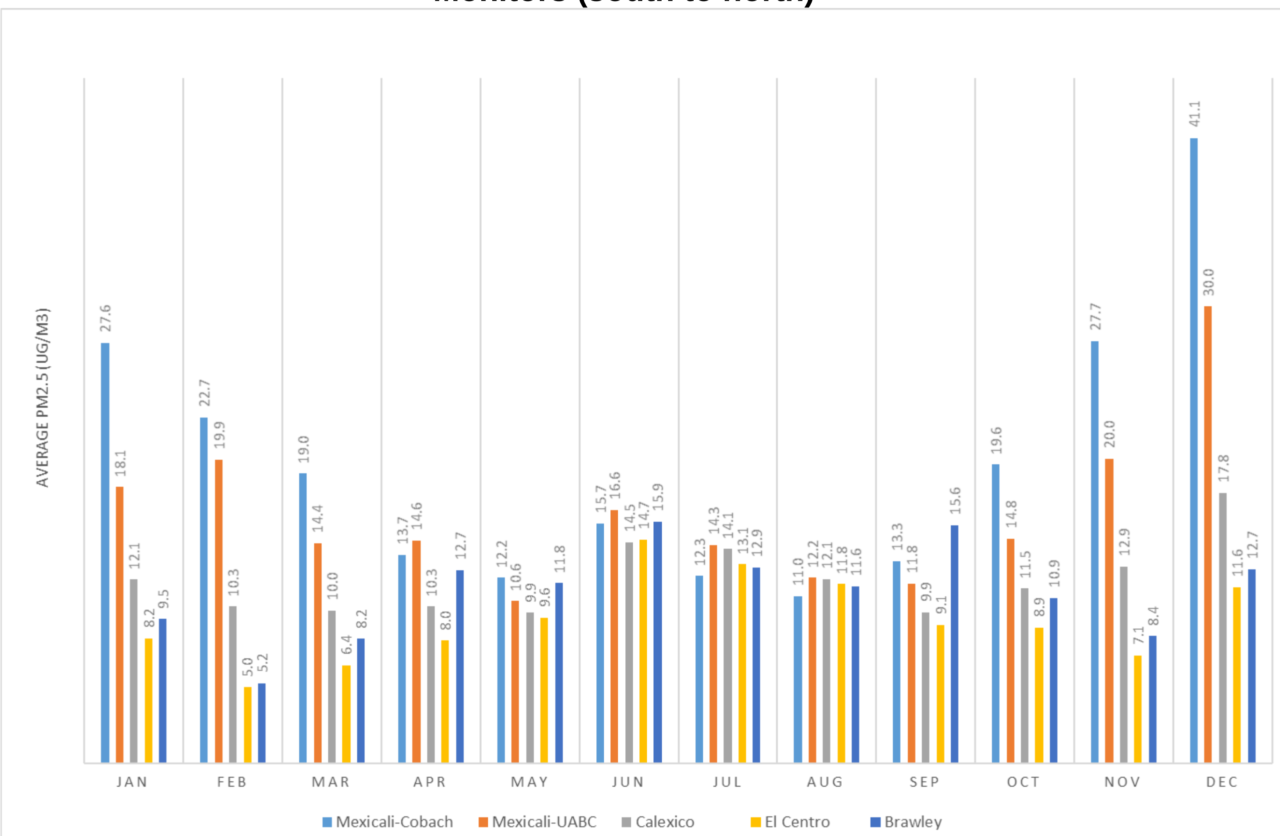


IV. Mexicali Monitoring Project and Data Analysis

In 2014, U.S. EPA approved funding for CARB to have PM2.5 and meteorological parameters monitored for a two-year period in Mexicali by a contractor to enrich the limited data collected by the Baja California's Secretaria de Proteccion al Ambiente (SPA). Monitoring under this project commenced in April 2016 at two locations in Mexicali: (1) Engineering Institute of the Autonomous University of Baja California (UABC); and, (2) Vocational School of Baja California (COBACH). UABC and COBACH are located in the urban area of Mexicali near the border, 2.6 and 2.0 miles from the Calexico monitor, respectively. PM2.5 is monitored at both of these sites using continuous instruments, and speciation and carbon samplers are being operated on a 1-in-6 day schedule at the UABC station. Monitoring protocols used in this project are required by the contract to mirror those used at the Calexico station as closely as possible for data comparability.

Historically, there has not been reliable PM2.5 data collected in Mexicali so this monitoring effort is very important to characterize the Mexicali regions impact on the air quality in the Imperial County PM2.5 NA, specifically at the Calexico site. Figure 20 below shows the monthly average PM2.5 at each PM2.5 monitor in Mexicali and the Imperial County PM2.5 NA (from south to north) using available data. In every month besides September, the Mexicali monitors record the highest average PM2.5 when compared to the Imperial PM2.5 monitors (Brawley recorded the highest average PM2.5 in September). The highest average PM2.5 concentrations at the Mexicali PM2.5 stations and at Calexico occur in December. Although the concentrations at El Centro and Brawley are elevated in December, they are highest in the summer months. This suggests that the El Centro and Brawley sites are less impacted by PM2.5 pollution in Mexicali than Calexico is and that the higher averages in the summer at these sites may be due to local sources.

Figure 20. Monthly Average PM2.5 at Mexicali and Imperial County PM2.5 NA Monitors (south to north)



Source: AQMIS (Air Quality Data Query Tool)

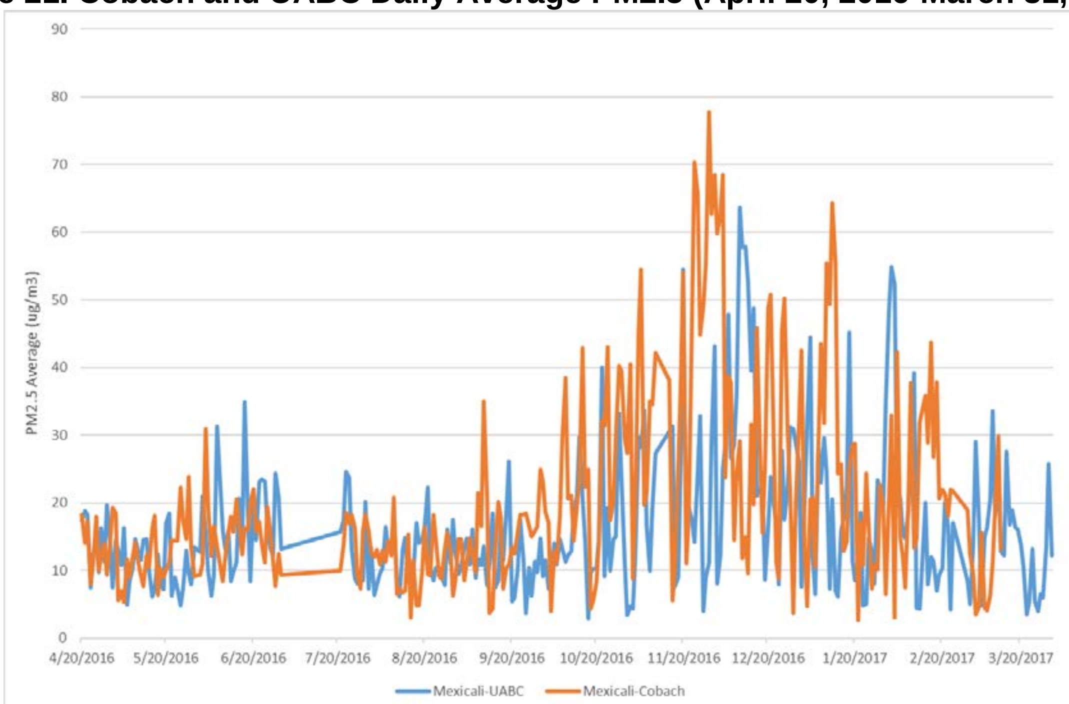
Table 7 below lists the monitoring dates of the PM2.5 monitors, the number of samples available at the time of this analysis, and the number of days over the 24-hour and annual PM2.5 standards. A decreasing gradient in PM2.5 concentrations is evident when moving from the south in Mexicali to the north in the Imperial County PM2.5 NA. Typically the concentrations at Brawley are higher than El Centro which also may be indicative of a local impact, especially in the summer months.

Table 7. Mexicali and Imperial Monitoring Concentration Analysis

Sites (South to North)	Sample Dates	Number of Samples	Days over 35 ug/m3	Days over 12 ug/m3
Cobach	4/20/16-3/31/17	296	44 (15%)	208 (70%)
UABC	4/20/16-3/31/17	314	17 (5%)	188 (60%)
Calexico	1/1/16-1/31/17	367	4 (1%)	140 (38%)
El Centro	1/1/16-12/29/16	122	0 (0%)	28 (23%)
Brawley	1/1/16-12/29/16	123	2 (2%)	39 (32%)

Figures 21 through 24 below show the daily average PM2.5 collected at each station in Mexicali and Imperial. Cobach typically measures higher PM2.5 than UABC. Between 4/20/16 and 3/31/17 the Cobach monitor recorded five days over the 1997 PM2.5 24-hour standard of 65 ug/m3. No other monitors (UABC and Imperial) recorded concentrations over this level.

Figure 21. Cobach and UABC Daily Average PM2.5 (April 20, 2016-March 31, 2017)



Like the Mexicali PM2.5 monitors, Calexico PM2.5 is the highest in the winter. In comparison, El Centro and Brawley record the highest PM2.5 concentrations in the summer. This suggests that the increased PM2.5 concentrations at El Centro and Brawley are impacted by different emission sources than those experienced at Calexico in the winter. This pattern of PM2.5 concentration differences between the three Imperial County PM2.5 NA sites can be seen in Figures 22-24. The Figures below show the PM2.5 concentrations at Calexico, El Centro, and Brawley in 2016 (through January 31, 2017 at Calexico).

Figure 22. Calexico Daily Average PM2.5 (January 1, 2016-January 31, 2017)

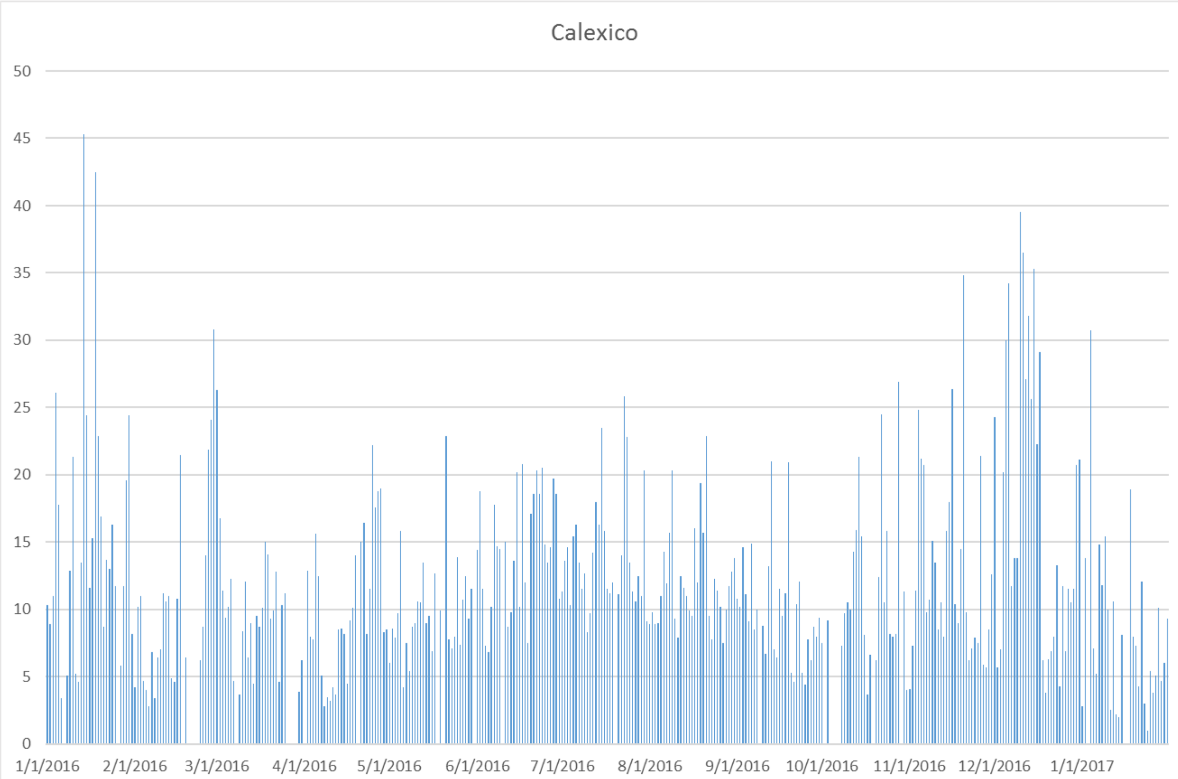


Figure 23. El Centro Daily Average PM2.5 (January 1, 2016-December 29, 2016)

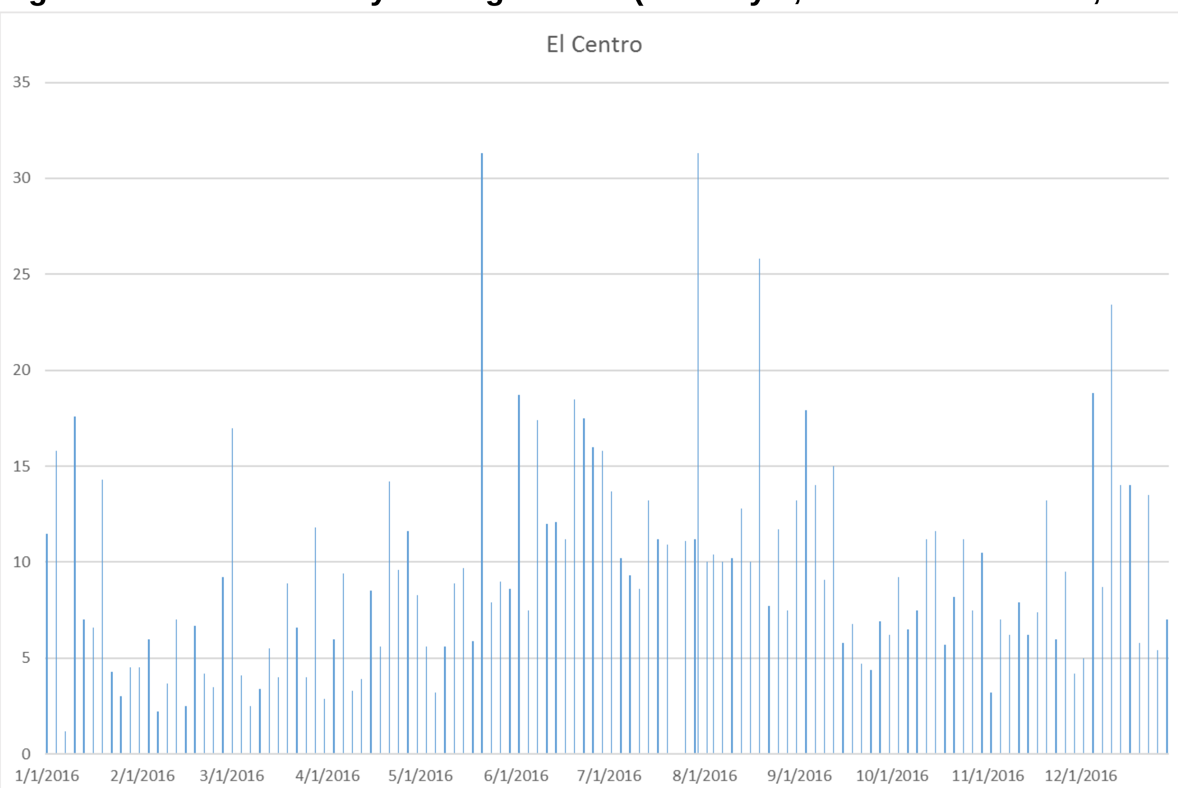
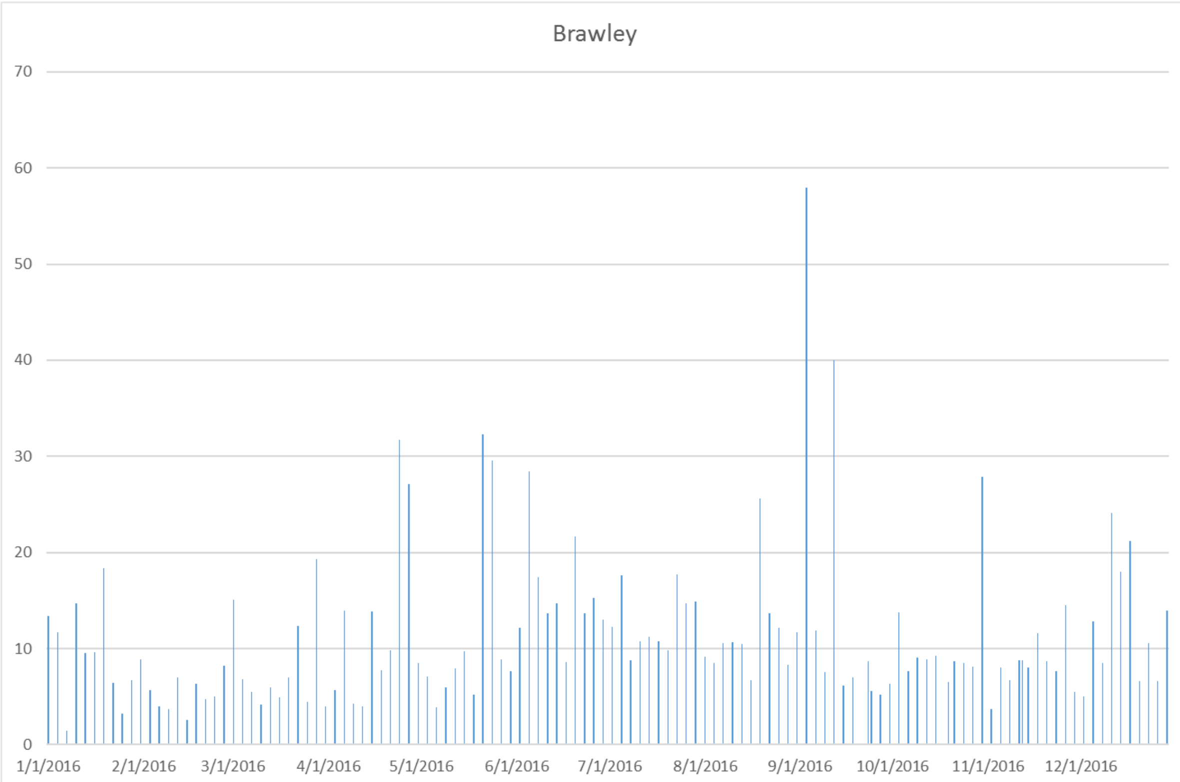


Figure 24. Brawley Daily Average PM2.5 (January 1, 2016-December 29, 2016)



APPENDIX B
$PM_{2.5}$ AND $PM_{2.5}$ PRECURSOR EMISSION INVENTORIES FOR THE IMPERIAL COUNTY $PM_{2.5}$ NONATTAINMENT AREA

Table B-1a. $PM_{2.5}$ and $PM_{2.5}$ Precursor Emissions by Major Source Category in the Imperial County $PM_{2.5}$ Nonattainment Area, 2012

Source Category	$PM_{2.5}$ (tons/day)	% Total	NH_3 (tons/day)	% Total	NO_X (tons/day)	% Total	SO_X (tons/day)	% Total	ROG (tons/day)	% Total
Stationary Sources										
Fuel Combustion	0.13	1.08%	0.00	0.00%	1.52	10.71%	0.00	1.74%	0.05	0.44%
Waste Disposal	0.00	0.00%	1.19	5.13%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Cleaning and Surface Coatings	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.41	3.44%
Petroleum Production and Marketing	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.50	4.17%
Industrial Processes	0.41	3.37%	0.00	0.00%	0.02	0.15%	0.00	0.00%	0.00	0.01%
Total Stationary Sources	**0.55**	**4.45%**	**1.19**	**5.13%**	**1.54**	**10.85%**	**0.00**	**1.74%**	**0.96**	**8.06%**
Areawide Sources										
Solvent Evaporation	0.00	0.00%	12.87	55.37%	0.00	0.00%	0.00	0.00%	3.01	25.35%
Miscellaneous Processes	10.58	86.01%	9.07	39.01%	0.37	2.62%	0.05	18.86%	2.13	17.87%
Total Areawide Sources	**10.58**	**86.01%**	**21.94**	**94.37%**	**0.37**	**2.62%**	**0.05**	**18.86%**	**5.14**	**43.22%**
Mobile Sources										
On-Road Vehicles	0.19	1.55%	0.11	0.49%	5.31	37.38%	0.02	5.85%	1.77	14.86%
Off-Road Vehicles	0.98	7.99%	0.00	0.01%	6.98	49.15%	0.21	73.56%	4.03	33.86%
Total Mobile Sources	**1.17**	**9.54%**	**0.12**	**0.50%**	**12.28**	**86.53%**	**0.22**	**79.40%**	**5.79**	**48.71%**
Total for Imperial County	**12.30**	**100.00%**	**23.24**	**100.00%**	**14.19**	**100.00%**	**0.28**	**100.00%**	**11.89**	**100.00%**

Notes:

Emissions for the Imperial County $PM_{2.5}$ Nonattainment Area were queried from the California Emissions Projection Analysis Model (CEPAM), Version 1.05.

Totals may not add up due to rounding.

Table B-1b. Condensable and Filterable $PM_{2.5}$ Emissions by Major Source Category in the Imperial County $PM_{2.5}$ Nonattainment Area, 2012

Source Category	Total $PM_{2.5}$ (tons/day)	Condensable $PM_{2.5}$ (tons/day)	Filterable $PM_{2.5}$ (tons/day)
Stationary Sources			
Fuel Combustion	0.133	0.030	0.103
Electric Utilities	*0.055*	*0.028*	*0.028*
Cogeneration	*0.002*	*0.001*	*0.001*
Manufacturing and Industrial	*0.010*	*0*	*0.010*
Food and Agricultural Processing	*0.005*	*0.001*	*0.004*
Service and Commercial	*0.060*	*0.000*	*0.060*
Other (Fuel Combustion)	*0.000*	*0.000*	*0.000*
Waste Disposal	0	0	0
Sewage Treatment	*0*	*0*	*0*
Landfills	*0*	*0*	*0*
Other (Waste Disposal)	*0*	*0*	*0*
Cleaning and Surface Coatings	0	0	0
Laundering	*0*	*0*	*0*
Degreasing	*0*	*0*	*0*
Coatings and Related Process Solvents	*0*	*0*	*0*
Adhesives and Sealants	*0*	*0*	*0*
Petroleum Production and Marketing	0	0	0
Petroleum Refining	*0*	*0*	*0*
Petroleum Marketing	*0*	*0*	*0*
Other (Petroleum Production and Marketing)	*0*	*0*	*0*
Industrial Processes	0.415	0.009	0.406
Food and Agriculture	*0.048*	*0.004*	*0.045*
Mineral Processes	*0.367*	*0.005*	*0.361*
Metal Processes	*0*	*0*	*0*
Other (Industrial Processes)	*0*	*0*	*0*
Total Stationary Sources	**0.548**	**0.039**	**0.509**
Areawide Sources			
Solvent Evaporation	0	0	0
Consumer Products	*0*	*0*	*0*
Architectural Coatings and Related Process Solvents	*0*	*0*	*0*
Pesticides/Fertilizers	*0*	*0*	*0*
Asphalt Paving/Roofing	*0*	*0*	*0*
Miscellaneous Processes	10.576	0.056	10.520
Residential Fuel Combustion	*0.037*	*0*	*0.037*
Farming Operations	*0.906*	*0*	*0.906*
Construction and Demolition	*0.177*	*0*	*0.177*
Paved Road Dust	*0.123*	*0*	*0.123*
Unpaved Road Dust	*4.762*	*0*	*4.762*
Fugitive Windblown Dust	*3.689*	*0*	*3.689*
Fires	*0.003*	*0*	*0.003*
Managed Burning and Disposal	*0.824*	*0*	*0.824*
Cooking	*0.056*	*0.056*	*0.000*
Other (Miscellaneous Processes)	*0*	*0*	*0*
Total Areawide Sources	**10.576**	**0.056**	**10.520**
Mobile Sources			
On-Road Vehicles	0.191	--	--
Off-Road Vehicles	0.982	--	--
Total Mobile Sources	**1.173**	--	--
Total for Imperial County	**12.297**	**--**	**--**

Notes:

Emissions for the Imperial County $PM_{2.5}$ Nonattainment Area were queried from the California Emissions Projection Analysis Model (CEPAM), Version 1.05.

Totals may not add up due to rounding.

A value of "0" in the table represents a true zero, while those shown as "0.000" represent nonzero values which round to less than 0.001.

"--" indicates that the portion of condensable/filterable $PM_{2.5}$ is unknown/unmeasurable.

The condensable portion of each inventory category was calculated using an individual, source-specific conversion factor applied to the reported $PM_{2.5}$ emission value. The filterable portion was then calculated as the difference between the $PM_{2.5}$ emission value and its condensable portion.

Table B-2a. $PM_{2.5}$ and $PM_{2.5}$ Precursor Emissions by Major Source Category in the Imperial County $PM_{2.5}$ Nonattainment Area, 2019

Source Category	$PM_{2.5}$ (tons/day)	% Total	NH_3 (tons/day)	% Total	NO_X (tons/day)	% Total	SO_X (tons/day)	% Total	ROG (tons/day)	% Total
Stationary Sources										
Fuel Combustion	0.11	0.97%	0.00	0.00%	1.33	13.03%	0.00	1.65%	0.04	0.40%
Electric Utilities	*0.04*	*0.38%*	*0.00*	*0.00%*	*0.36*	*3.48%*	*0.00*	*0.00%*	*0.01*	*0.09%*
Cogeneration	*0.00*	*0.02%*	*0.00*	*0.00%*	*0.03*	*0.25%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Manufacturing and Industrial	*0.01*	*0.09%*	*0.00*	*0.00%*	*0.35*	*3.40%*	*0.00*	*0.60%*	*0.01*	*0.06%*
Food and Agricultural Processing	*0.00*	*0.03%*	*0.00*	*0.00%*	*0.06*	*0.61%*	*0.00*	*0.24%*	*0.00*	*0.03%*
Service and Commercial	*0.05*	*0.46%*	*0.00*	*0.00%*	*0.54*	*5.29%*	*0.00*	*0.81%*	*0.02*	*0.19%*
Other (Fuel Combustion)	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.03%*
Waste Disposal	0.00	0.00%	1.21	5.39%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Sewage Treatment	*0.00*	*0.00%*	*0.00*	*0.01%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Landfills	*0.00*	*0.00%*	*0.06*	*0.28%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Other (Waste Disposal)	*0.00*	*0.00%*	*1.14*	*5.11%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Cleaning and Surface Coatings	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.49	4.56%
Laundering	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.01*	*0.08%*
Degreasing	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.24*	*2.25%*
Coatings and Related Process Solvents	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.17*	*1.56%*
Adhesives and Sealants	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.07*	*0.67%*
Petroleum Production and Marketing	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.45	4.15%
Petroleum Refining	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.02%*
Petroleum Marketing	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.44*	*4.11%*
Other (Petroleum Production and Marketing)	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.01%*
Industrial Processes	0.55	4.71%	0.00	0.00%	0.02	0.22%	0.00	0.00%	0.00	0.02%
Food and Agriculture	*0.06*	*0.48%*	*0.00*	*0.00%*	*0.02*	*0.19%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Mineral Processes	*0.49*	*4.23%*	*0.00*	*0.00%*	*0.00*	*0.03%*	*0.00*	*0.00%*	*0.00*	*0.01%*
Metal Processes	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Other (Industrial Processes)	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Total Stationary Sources	**0.66**	**5.68%**	**1.21**	**5.39%**	**1.35**	**13.24%**	**0.00**	**1.65%**	**0.98**	**9.13%**
Areawide Sources										
Solvent Evaporation	0.00	0.00%	12.00	53.68%	0.00	0.00%	0.00	0.00%	2.93	27.17%
Consumer Products	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.97*	*9.01%*
Architectural Coatings and Related Process Solvents	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.43*	*3.98%*
Pesticides/Fertilizers	*0.00*	*0.00%*	*12.00*	*53.68%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*1.40*	*13.03%*
Asphalt Paving/Roofing	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.12*	*1.15%*
Miscellaneous Processes	9.97	85.32%	9.05	40.47%	0.33	3.19%	0.05	15.83%	2.04	18.94%
Residential Fuel Combustion	*0.04*	*0.31%*	*0.00*	*0.01%*	*0.07*	*0.68%*	*0.00*	*0.81%*	*0.03*	*0.30%*
Farming Operations	*0.85*	*7.31%*	*8.60*	*38.49%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*1.47*	*13.64%*
Construction and Demolition	*0.27*	*2.35%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Paved Road Dust	*0.15*	*1.28%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Unpaved Road Dust	*4.18*	*35.74%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Fugitive Windblown Dust	*3.69*	*31.54%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Fires	*0.00*	*0.02%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.01%*
Managed Burning and Disposal	*0.72*	*6.18%*	*0.11*	*0.49%*	*0.26*	*2.50%*	*0.04*	*15.02%*	*0.53*	*4.88%*
Cooking	*0.07*	*0.60%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.01*	*0.11%*
Other (Miscellaneous Processes)	*0.00*	*0.00%*	*0.33*	*1.48%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Total Areawide Sources	**9.97**	**85.32%**	**21.05**	**94.15%**	**0.33**	**3.19%**	**0.05**	**15.83%**	**4.97**	**46.11%**
Mobile Sources										
On-Road Vehicles	0.09	0.80%	0.10	0.45%	2.86	28.03%	0.02	5.91%	1.17	10.83%
Off-Road Vehicles	0.96	8.20%	0.00	0.01%	5.67	55.54%	0.23	76.61%	3.65	33.93%
Total Mobile Sources	**1.05**	**9.00%**	**0.10**	**0.46%**	**8.54**	**83.57%**	**0.25**	**82.53%**	**4.82**	**44.76%**
Total for Imperial County	**11.69**	**100.00%**	**22.35**	**100.00%**	**10.22**	**100.00%**	**0.30**	**100.00%**	**10.77**	**100.00%**

Notes:

Emissions for the Imperial County $PM_{2.5}$ Nonattainment Area were queried from the California Emissions Projection Analysis Model (CEPAM), Version 1.05.

Totals may not add up due to rounding.

Table B-2b. Condensable and Filterable $PM_{2.5}$ Emissions by Major Source Category in the Imperial County $PM_{2.5}$ Nonattainment Area, 2019

Source Category	Total $PM_{2.5}$ (tons/day)	Condensable $PM_{2.5}$ (tons/day)	Filterable $PM_{2.5}$ (tons/day)
Stationary Sources			
Fuel Combustion	0.114	0.024	0.089
Electric Utilities	*0.044*	*0.022*	*0.022*
Cogeneration	*0.002*	*0.001*	*0.001*
Manufacturing and Industrial	*0.010*	*0*	*0.010*
Food and Agricultural Processing	*0.003*	*0.001*	*0.002*
Service and Commercial	*0.054*	*0.000*	*0.054*
Other (Fuel Combustion)	*0.000*	*0.000*	*0.000*
Waste Disposal	0	0	0
Sewage Treatment	*0*	*0*	*0*
Landfills	*0*	*0*	*0*
Other (Waste Disposal)	*0*	*0*	*0*
Cleaning and Surface Coatings	0	0	0
Laundering	*0*	*0*	*0*
Degreasing	*0*	*0*	*0*
Coatings and Related Process Solvents	*0*	*0*	*0*
Adhesives and Sealants	*0*	*0*	*0*
Petroleum Production and Marketing	0	0	0
Petroleum Refining	*0*	*0*	*0*
Petroleum Marketing	*0*	*0*	*0*
Other (Petroleum Production and Marketing)	*0*	*0*	*0*
Industrial Processes	0.551	0.010	0.541
Food and Agriculture	*0.056*	*0.004*	*0.053*
Mineral Processes	*0.494*	*0.006*	*0.488*
Metal Processes	*0*	*0*	*0*
Other (Industrial Processes)	*0*	*0*	*0*
Total Stationary Sources	**0.664**	**0.034**	**0.630**
Areawide Sources			
Solvent Evaporation	0	0	0
Consumer Products	*0*	*0*	*0*
Architectural Coatings and Related Process Solvents	*0*	*0*	*0*
Pesticides/Fertilizers	*0*	*0*	*0*
Asphalt Paving/Roofing	*0*	*0*	*0*
Miscellaneous Processes	9.972	0.070	9.901
Residential Fuel Combustion	*0.036*	*0*	*0.036*
Farming Operations	*0.854*	*0*	*0.854*
Construction and Demolition	*0.274*	*0*	*0.274*
Paved Road Dust	*0.150*	*0*	*0.150*
Unpaved Road Dust	*4.177*	*0*	*4.177*
Fugitive Windblown Dust	*3.686*	*0*	*3.686*
Fires	*0.003*	*0*	*0.003*
Managed Burning and Disposal	*0.722*	*0*	*0.722*
Cooking	*0.071*	*0.070*	*0.000*
Other (Miscellaneous Processes)	*0*	*0*	*0*
Total Areawide Sources	**9.972**	**0.070**	**9.901**
Mobile Sources			
On-Road Vehicles	0.093	--	--
Off-Road Vehicles	0.958	--	--
Total Mobile Sources	**1.052**	--	--
Total for Imperial County	**11.687**	**--**	**--**

Notes:

Emissions for the Imperial County $PM_{2.5}$ Nonattainment Area were queried from the California Emissions Projection Analysis Model (CEPAM), Version 1.05.

Totals may not add up due to rounding.

A value of "0" in the table represents a true zero, while those shown as "0.000" represent nonzero values which round to less than 0.001.

"--" indicates that the portion of condensable/filterable $PM_{2.5}$ is unknown/unmeasurable.

The condensable portion of each inventory category was calculated using an individual, source-specific conversion factor applied to the reported $PM_{2.5}$ emission value. The filterable portion was then calculated as the difference between the $PM_{2.5}$ emission value and its condensable portion.

Table B-3a. $PM_{2.5}$ and $PM_{2.5}$ Precursor Emissions by Major Source Category in the Imperial County $PM_{2.5}$ Nonattainment Area, 2021

Source Category	$PM_{2.5}$ (tons/day)	% Total	NH_3 (tons/day)	% Total	NO_X (tons/day)	% Total	SO_X (tons/day)	% Total	ROG (tons/day)	% Total
Stationary Sources										
Fuel Combustion	0.12	1.03%	0.00	0.00%	1.42	14.85%	0.01	1.78%	0.05	0.42%
Electric Utilities	*0.05*	*0.39%*	*0.00*	*0.00%*	*0.37*	*3.84%*	*0.00*	*0.00%*	*0.01*	*0.09%*
Cogeneration	*0.00*	*0.02%*	*0.00*	*0.00%*	*0.03*	*0.28%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Manufacturing and Industrial	*0.01*	*0.09%*	*0.00*	*0.00%*	*0.38*	*3.93%*	*0.00*	*0.64%*	*0.01*	*0.06%*
Food and Agricultural Processing	*0.00*	*0.03%*	*0.00*	*0.00%*	*0.06*	*0.62%*	*0.00*	*0.24%*	*0.00*	*0.03%*
Service and Commercial	*0.06*	*0.51%*	*0.00*	*0.00%*	*0.59*	*6.18%*	*0.00*	*0.91%*	*0.02*	*0.21%*
Other (Fuel Combustion)	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.03%*
Waste Disposal	0.00	0.00%	1.21	5.45%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Sewage Treatment	*0.00*	*0.00%*	*0.00*	*0.01%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Landfills	*0.00*	*0.00%*	*0.07*	*0.30%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Other (Waste Disposal)	*0.00*	*0.00%*	*1.14*	*5.15%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Cleaning and Surface Coatings	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.51	4.77%
Laundering	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.01*	*0.09%*
Degreasing	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.25*	*2.35%*
Coatings and Related Process Solvents	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.17*	*1.64%*
Adhesives and Sealants	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.07*	*0.70%*
Petroleum Production and Marketing	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.43	4.01%
Petroleum Refining	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.02%*
Petroleum Marketing	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.42*	*3.97%*
Other (Petroleum Production and Marketing)	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.02%*
Industrial Processes	0.59	5.00%	0.00	0.00%	0.02	0.24%	0.00	0.00%	0.00	0.02%
Food and Agriculture	*0.06*	*0.49%*	*0.00*	*0.00%*	*0.02*	*0.21%*	*0.00*	*0.00%*	*0.00*	*0.01%*
Mineral Processes	*0.53*	*4.50%*	*0.00*	*0.00%*	*0.00*	*0.03%*	*0.00*	*0.00%*	*0.00*	*0.02%*
Metal Processes	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Other (Industrial Processes)	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Total Stationary Sources	**0.71**	**6.03%**	**1.21**	**5.45%**	**1.45**	**15.09%**	**0.01**	**1.78%**	**0.98**	**9.22%**
Areawide Sources										
Solvent Evaporation	0.00	0.00%	11.82	53.27%	0.00	0.00%	0.00	0.00%	2.97	27.89%
Consumer Products	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*1.01*	*9.45%*
Architectural Coatings and Related Process Solvents	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.45*	*4.25%*
Pesticides/Fertilizers	*0.00*	*0.00%*	*11.82*	*53.27%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*1.38*	*12.96%*
Asphalt Paving/Roofing	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.13*	*1.22%*
Miscellaneous Processes	9.97	84.99%	9.06	40.83%	0.32	3.36%	0.05	15.60%	2.03	19.05%
Residential Fuel Combustion	*0.04*	*0.31%*	*0.00*	*0.01%*	*0.07*	*0.74%*	*0.00*	*0.84%*	*0.03*	*0.30%*
Farming Operations	*0.84*	*7.19%*	*8.60*	*38.78%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*1.47*	*13.78%*
Construction and Demolition	*0.29*	*2.46%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Paved Road Dust	*0.16*	*1.34%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Unpaved Road Dust	*4.17*	*35.58%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Fugitive Windblown Dust	*3.68*	*31.41%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Fires	*0.00*	*0.02%*	*0.00*	*0.00%*	*0.00*	*0.01%*	*0.00*	*0.00%*	*0.00*	*0.01%*
Managed Burning and Disposal	*0.71*	*6.05%*	*0.11*	*0.49%*	*0.25*	*2.62%*	*0.04*	*14.76%*	*0.52*	*4.84%*
Cooking	*0.07*	*0.63%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.01*	*0.11%*
Other (Miscellaneous Processes)	*0.00*	*0.00%*	*0.34*	*1.55%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Total Areawide Sources	**9.97**	**84.99%**	**20.88**	**94.10%**	**0.32**	**3.36%**	**0.05**	**15.60%**	**5.01**	**46.94%**
Mobile Sources										
On-Road Vehicles	0.09	0.79%	0.10	0.44%	2.56	26.73%	0.02	5.99%	1.08	10.09%
Off-Road Vehicles	0.96	8.19%	0.00	0.01%	5.26	54.83%	0.23	76.63%	3.60	33.76%
Total Mobile Sources	**1.05**	**8.98%**	**0.10**	**0.45%**	**7.82**	**81.55%**	**0.25**	**82.62%**	**4.68**	**43.85%**
Total for Imperial County	**11.73**	**100.00%**	**22.19**	**100.00%**	**9.59**	**100.00%**	**0.30**	**100.00%**	**10.67**	**100.00%**

Notes:

Emissions for the Imperial County $PM_{2.5}$ Nonattainment Area were queried from the California Emissions Projection Analysis Model (CEPAM), Version 1.05.

Totals may not add up due to rounding.

Table B-3b. Condensable and Filterable $PM_{2.5}$ Emissions by Major Source Category in the Imperial County $PM_{2.5}$ Nonattainment Area, 2021

Source Category	Total $PM_{2.5}$ (tons/day)	Condensable $PM_{2.5}$ (tons/day)	Filterable $PM_{2.5}$ (tons/day)
Stationary Sources			
Fuel Combustion	0.121	0.025	0.096
Electric Utilities	*0.046*	*0.023*	*0.023*
Cogeneration	*0.002*	*0.001*	*0.001*
Manufacturing and Industrial	*0.011*	*0*	*0.011*
Food and Agricultural Processing	*0.003*	*0.001*	*0.002*
Service and Commercial	*0.059*	*0.000*	*0.059*
Other (Fuel Combustion)	*0.000*	*0.000*	*0.000*
Waste Disposal	0	0	0
Sewage Treatment	*0*	*0*	*0*
Landfills	*0*	*0*	*0*
Other (Waste Disposal)	*0*	*0*	*0*
Cleaning and Surface Coatings	0	0	0
Laundering	*0*	*0*	*0*
Degreasing	*0*	*0*	*0*
Coatings and Related Process Solvents	*0*	*0*	*0*
Adhesives and Sealants	*0*	*0*	*0*
Petroleum Production and Marketing	0	0	0
Petroleum Refining	*0*	*0*	*0*
Petroleum Marketing	*0*	*0*	*0*
Other (Petroleum Production and Marketing)	*0*	*0*	*0*
Industrial Processes	0.586	0.010	0.576
Food and Agriculture	*0.058*	*0.004*	*0.054*
Mineral Processes	*0.528*	*0.006*	*0.522*
Metal Processes	*0*	*0*	*0*
Other (Industrial Processes)	*0*	*0*	*0*
Total Stationary Sources	**0.707**	**0.035**	**0.672**
Areawide Sources			
Solvent Evaporation	0	0	0
Consumer Products	*0*	*0*	*0*
Architectural Coatings and Related Process Solvents	*0*	*0*	*0*
Pesticides/Fertilizers	*0*	*0*	*0*
Asphalt Paving/Roofing	*0*	*0*	*0*
Miscellaneous Processes	9.972	0.073	9.899
Residential Fuel Combustion	*0.036*	*0*	*0.036*
Farming Operations	*0.844*	*0*	*0.844*
Construction and Demolition	*0.289*	*0*	*0.289*
Paved Road Dust	*0.157*	*0*	*0.157*
Unpaved Road Dust	*4.175*	*0*	*4.175*
Fugitive Windblown Dust	*3.685*	*0*	*3.685*
Fires	*0.003*	*0*	*0.003*
Managed Burning and Disposal	*0.710*	*0*	*0.710*
Cooking	*0.074*	*0.073*	*0.000*
Other (Miscellaneous Processes)	*0*	*0*	*0*
Total Areawide Sources	**9.972**	**0.073**	**9.899**
Mobile Sources			
On-Road Vehicles	0.093	--	--
Off-Road Vehicles	0.961	--	--
Total Mobile Sources	**1.053**	--	--
Total for Imperial County	**11.733**	**--**	**--**

Notes:

Emissions for the Imperial County $PM_{2.5}$ Nonattainment Area were queried from the California Emissions Projection Analysis Model (CEPAM), Version 1.05.

Totals may not add up due to rounding.

A value of "0" in the table represents a true zero, while those shown as "0.000" represent nonzero values which round to less than 0.001.

"--" indicates that the portion of condensable/filterable $PM_{2.5}$ is unknown/unmeasurable.

The condensable portion of each inventory category was calculated using an individual, source-specific conversion factor applied to the reported $PM_{2.5}$ emission value. The filterable portion was then calculated as the difference between the $PM_{2.5}$ emission value and its condensable portion.

Table B-4a. $PM_{2.5}$ and $PM_{2.5}$ Precursor Emissions by Major Source Category in the Imperial County $PM_{2.5}$ Nonattainment Area, 2022

Source Category	$PM_{2.5}$ (tons/day)	% Total	NH_3 (tons/day)	% Total	NO_X (tons/day)	% Total	SO_X (tons/day)	% Total	ROG (tons/day)	% Total
Stationary Sources										
Fuel Combustion	0.12	1.04%	0.00	0.00%	1.42	15.47%	0.01	1.78%	0.05	0.42%
Electric Utilities	*0.05*	*0.40%*	*0.00*	*0.00%*	*0.38*	*4.10%*	*0.00*	*0.00%*	*0.01*	*0.10%*
Cogeneration	*0.00*	*0.02%*	*0.00*	*0.00%*	*0.03*	*0.29%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Manufacturing and Industrial	*0.01*	*0.09%*	*0.00*	*0.00%*	*0.37*	*4.05%*	*0.00*	*0.64%*	*0.01*	*0.06%*
Food and Agricultural Processing	*0.00*	*0.03%*	*0.00*	*0.00%*	*0.06*	*0.63%*	*0.00*	*0.24%*	*0.00*	*0.03%*
Service and Commercial	*0.06*	*0.51%*	*0.00*	*0.00%*	*0.59*	*6.39%*	*0.00*	*0.91%*	*0.02*	*0.21%*
Other (Fuel Combustion)	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.03%*
Waste Disposal	0.00	0.00%	1.21	5.46%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Sewage Treatment	*0.00*	*0.00%*	*0.00*	*0.01%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Landfills	*0.00*	*0.00%*	*0.07*	*0.30%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Other (Waste Disposal)	*0.00*	*0.00%*	*1.14*	*5.16%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Cleaning and Surface Coatings	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.52	4.90%
Laundering	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.01*	*0.09%*
Degreasing	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.26*	*2.40%*
Coatings and Related Process Solvents	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.18*	*1.70%*
Adhesives and Sealants	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.08*	*0.72%*
Petroleum Production and Marketing	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.42	3.90%
Petroleum Refining	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.02%*
Petroleum Marketing	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.41*	*3.87%*
Other (Petroleum Production and Marketing)	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.01%*
Industrial Processes	0.60	5.18%	0.00	0.00%	0.02	0.25%	0.00	0.00%	0.00	0.02%
Food and Agriculture	*0.06*	*0.50%*	*0.00*	*0.00%*	*0.02*	*0.22%*	*0.00*	*0.00%*	*0.00*	*0.01%*
Mineral Processes	*0.54*	*4.68%*	*0.00*	*0.00%*	*0.00*	*0.03%*	*0.00*	*0.00%*	*0.00*	*0.01%*
Metal Processes	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Other (Industrial Processes)	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Total Stationary Sources	**0.72**	**6.23%**	**1.21**	**5.46%**	**1.45**	**15.72%**	**0.01**	**1.78%**	**0.99**	**9.25%**
Areawide Sources										
Solvent Evaporation	0.00	0.00%	11.76	53.13%	0.00	0.00%	0.00	0.00%	2.99	28.00%
Consumer Products	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*1.02*	*9.55%*
Architectural Coatings and Related Process Solvents	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.46*	*4.31%*
Pesticides/Fertilizers	*0.00*	*0.00%*	*11.76*	*53.13%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*1.38*	*12.89%*
Asphalt Paving/Roofing	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.13*	*1.25%*
Miscellaneous Processes	9.85	84.68%	9.06	40.94%	0.32	3.48%	0.05	15.52%	2.03	19.01%
Residential Fuel Combustion	*0.04*	*0.31%*	*0.00*	*0.01%*	*0.07*	*0.77%*	*0.00*	*0.84%*	*0.03*	*0.30%*
Farming Operations	*0.84*	*7.22%*	*8.60*	*38.87%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*1.47*	*13.77%*
Construction and Demolition	*0.29*	*2.53%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Paved Road Dust	*0.17*	*1.43%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Unpaved Road Dust	*4.05*	*34.78%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Fugitive Windblown Dust	*3.68*	*31.68%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Fires	*0.00*	*0.02%*	*0.00*	*0.00%*	*0.00*	*0.01%*	*0.00*	*0.00%*	*0.00*	*0.01%*
Managed Burning and Disposal	*0.71*	*6.07%*	*0.11*	*0.48%*	*0.25*	*2.71%*	*0.04*	*14.68%*	*0.51*	*4.81%*
Cooking	*0.07*	*0.64%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.01*	*0.12%*
Other (Miscellaneous Processes)	*0.00*	*0.00%*	*0.35*	*1.57%*	*0.00*	*0.00%*	*0.00*	*0.00%*	*0.00*	*0.00%*
Total Areawide Sources	**9.85**	**84.68%**	**20.82**	**94.07%**	**0.32**	**3.48%**	**0.05**	**15.52%**	**5.02**	**47.00%**
Mobile Sources										
On-Road Vehicles	0.10	0.83%	0.10	0.46%	2.41	26.18%	0.02	6.15%	1.08	10.15%
Off-Road Vehicles	0.96	8.26%	0.00	0.01%	5.03	54.62%	0.23	76.55%	3.59	33.61%
Total Mobile Sources	**1.06**	**9.09%**	**0.10**	**0.47%**	**7.44**	**80.80%**	**0.25**	**82.70%**	**4.67**	**43.75%**
Total for Imperial County	**11.63**	**100.00%**	**22.14**	**100.00%**	**9.21**	**100.00%**	**0.30**	**100.00%**	**10.67**	**100.00%**

Notes:

Emissions for the Imperial County $PM_{2.5}$ Nonattainment Area were queried from the California Emissions Projection Analysis Model (CEPAM), Version 1.05.

Totals may not add up due to rounding.

Table B-4b. Condensable and Filterable $PM_{2.5}$ Emissions by Major Source Category in the Imperial County $PM_{2.5}$ Nonattainment Area, 2022

Source Category	Total $PM_{2.5}$ (tons/day)	Condensable $PM_{2.5}$ (tons/day)	Filterable $PM_{2.5}$ (tons/day)
Stationary Sources			
Fuel Combustion	0.121	0.026	0.096
Electric Utilities	*0.047*	*0.023*	*0.023*
Cogeneration	*0.002*	*0.001*	*0.001*
Manufacturing and Industrial	*0.011*	*0*	*0.011*
Food and Agricultural Processing	*0.003*	*0.001*	*0.002*
Service and Commercial	*0.059*	*0.000*	*0.059*
Other (Fuel Combustion)	*0.000*	*0.000*	*0.000*
Waste Disposal	0	0	0
Sewage Treatment	*0*	*0*	*0*
Landfills	*0*	*0*	*0*
Other (Waste Disposal)	*0*	*0*	*0*
Cleaning and Surface Coatings	0	0	0
Laundering	*0*	*0*	*0*
Degreasing	*0*	*0*	*0*
Coatings and Related Process Solvents	*0*	*0*	*0*
Adhesives and Sealants	*0*	*0*	*0*
Petroleum Production and Marketing	0	0	0
Petroleum Refining	*0*	*0*	*0*
Petroleum Marketing	*0*	*0*	*0*
Other (Petroleum Production and Marketing)	*0*	*0*	*0*
Industrial Processes	0.603	0.010	0.593
Food and Agriculture	*0.059*	*0.004*	*0.055*
Mineral Processes	*0.545*	*0.006*	*0.538*
Metal Processes	*0*	*0*	*0*
Other (Industrial Processes)	*0*	*0*	*0*
Total Stationary Sources	**0.725**	**0.036**	**0.689**
Areawide Sources			
Solvent Evaporation	0	0	0
Consumer Products	*0*	*0*	*0*
Architectural Coatings and Related Process Solvents	*0*	*0*	*0*
Pesticides/Fertilizers	*0*	*0*	*0*
Asphalt Paving/Roofing	*0*	*0*	*0*
Miscellaneous Processes	9.850	0.074	9.776
Residential Fuel Combustion	*0.036*	*0*	*0.036*
Farming Operations	*0.840*	*0*	*0.840*
Construction and Demolition	*0.295*	*0*	*0.295*
Paved Road Dust	*0.167*	*0*	*0.167*
Unpaved Road Dust	*4.046*	*0*	*4.046*
Fugitive Windblown Dust	*3.685*	*0*	*3.685*
Fires	*0.003*	*0*	*0.003*
Managed Burning and Disposal	*0.706*	*0*	*0.706*
Cooking	*0.074*	*0.074*	*0.000*
Other (Miscellaneous Processes)	*0*	*0*	*0*
Total Areawide Sources	**9.850**	**0.074**	**9.776**
Mobile Sources			
On-Road Vehicles	0.096	--	--
Off-Road Vehicles	0.961	--	--
Total Mobile Sources	**1.057**	--	--
Total for Imperial County	**11.632**	**--**	**--**

Notes:

Emissions for the Imperial County $PM_{2.5}$ Nonattainment Area were queried from the California Emissions Projection Analysis Model (CEPAM), Version 1.05.

Totals may not add up due to rounding.

A value of "0" in the table represents a true zero, while those shown as "0.000" represent nonzero values which round to less than 0.001.

"--" indicates that the portion of condensable/filterable $PM_{2.5}$ is unknown/unmeasurable.

The condensable portion of each inventory category was calculated using an individual, source-specific conversion factor applied to the reported $PM_{2.5}$ emission value. The filterable portion was then calculated as the difference between the $PM_{2.5}$ emission value and its condensable portion.

APPENDIX C
REASONABLY AVAILABLE CONTROL MEASURE ANALYSIS FOR AREA SOURCE CONTROL MEASURES

Table C-1. Reasonably Available Control Measure Analysis for Area Source Control Measures in support of the Imperial County 2018 Annual $PM_{2.5}$ State Implementation Plan

Source Category	USEPA (or Other) Emission Reduction Measure(s) from Menu of Controls[1]	Evaluation of USEPA Measure
Construction Activities	Dust Control Plan	The control measure recommended by the USEPA involves implementation of a dust control plan that includes chemical suppression and water treatment of disturbed soil at construction sites. ICAPCD has established Rule 801, Construction and Earthmoving Activities, to control particulate matter emissions from construction activities. Rule 801 establishes a 20 percent opacity limit and control requirements for construction and earthmoving activities. Construction sites greater than 5 acres in size for non-residential developments or 10 acres in size for residential developments are required to develop a dust control plan. The dust control plan must feature best available control measures for fugitive dust, including water or chemical stabilization. Rule 801 was approved by the USEPA as BACM in 2013.
Open Burning	Substitution of chipping, shredding, and landfilling for open burning	This measure requires residents to either landfill or chip and shred yard waste instead of burning it (this is related to open burning of land-clearing debris for developments). This substitution can substantially reduce directly-emitted $PM_{2.5}$. ICAPCD Rule 421, Open Burning, prohibits the use of open outdoor fires for the purpose of disposal, with the exception of dwellings located in areas that are not serviced on a weekly basis. In these cases, the incinerator must be designed in such a way as to not discharge smoke or particulate into any adjacent property or residences such as to create a nuisance.
Paved Roads	Reduce emissions from paved roads by keeping roads clear of excess dust and paving/ stabilizing road shoulders.	The control measures recommended by the USEPA involve paving or stabilizing roadway shoulders and implementing other measures to keep road dust levels low. ICAPCD has established Rule 805, Paved and Unpaved Roads, which includes control measures for paving of road shoulders and other controls to limit visible dust emissions to 20 percent opacity. ICAPCD has also established Rule 803, Carry-out and Track-out, which includes various control measures for preventing fugitive dust emissions related to the carry-out/track-out of bulk material onto paved roadways. Both Rules 803 and Rule 805 were approved by the USEPA as BACM in 2013.

Table C-1. Reasonably Available Control Measure Analysis for Area Source Control Measures in support of the Imperial County 2018 Annual $PM_{2.5}$ State Implementation Plan

Source Category	USEPA (or Other) Emission Reduction Measure(s) from Menu of Controls[1]	Evaluation of USEPA Measure
Residential Wood Burning	Reduce emissions from residential home heating through use of cleaner fuel sources	The control measures recommended by the USEPA involve use of gas logs instead of fireplaces, replacement of traditional woodstoves with New Source Performance Standard (NSPS) compliant woodstoves, and an education and advisory program. ICAPCD Rule 900, New Source Performance Standards, incorporates by reference 40 CFR Part 60 Subpart AAA, Standards of Performance for New Residential Wood Heaters; however, Rule 900 exempts any stationary source that would be required to obtain a permit solely because it is subject to Subpart AAA. In its review of RACM established by other $PM_{2.5}$ Moderate nonattainment areas, ICAPCD recognizes that there are additional control measures that can be applied to residential wood burning involving fireplaces and woodstoves. Therefore, ICAPCD is developing a new rule that would require new wood burning fireplaces and heaters to comply with NSPS certification requirements in effect at the time of installation. This rule would be adopted in or before December 2018 and implementation would begin prior to April 15, 2019. Additionally, ICAPCD is also developing a rule that would curtail residential wood burning in the city of Calexico when forecasted 24-hour $PM_{2.5}$ concentrations are above 35 $\mu g/m^3$ at the Calexico ambient air quality monitoring station. As part of the successful implementation of this rule, ICAPCD will educate the populace on the health reasons for curtailment (i.e., “no burn”) days through various advertising campaigns. Similar rules have been adopted by other air quality management districts (AQMDs), including the Bay Area AQMD (Regulation 6, Rule 3), Sacramento Metropolitan AQMD (Rule 421), and South Coast AQMD (Rule 445). This rule would be adopted in or before December 2018 and implementation would begin in 2020.
Residential Home Heating	Switch to Low Sulfur Fuel	This measure recommends a switch from high sulfur (2,500 parts per million [ppm] sulfur content) to low sulfur (500 ppm) home heating oil for residential users. Emission Inventory Category 610-606-1220-0000, Residential Fuel Combustion – Space Heating – Distillate Oil, does not measurably contribute to the direct $PM_{2.5}$ emissions inventory for the Imperial County $PM_{2.5}$ Nonattainment Area. Therefore, this control measure does not apply.

Table C-1. Reasonably Available Control Measure Analysis for Area Source Control Measures in support of the Imperial County 2018 Annual $PM_{2.5}$ State Implementation Plan

Source Category	USEPA (or Other) Emission Reduction Measure(s) from Menu of Controls[1]	Evaluation of USEPA Measure
Unpaved Roads	Reduce emissions from unpaved roads	The control measures recommended by the USEPA involve use of dust suppressants and other measures to limit visible dust emissions to 20 percent opacity. ICAPCD has established Rule 805, Paved and Unpaved Roads. Under Rule 805, control measures such as paving, application of chemical stabilizers, wetting of roads, restricted vehicle access, and other measures must be implemented to limit visible dust emissions to 20 percent opacity. Additionally, new unpaved roads are not allowed in areas with populations of 500 or more, unless they are temporary unpaved roads. Rule 805 was approved by the USEPA as BACM in 2013.

Notes:

[1] List of control measures obtained from USEPA. 2013. Menu of Control Measures for NAAQS Implementation. August 6. Available at: https://www.epa.gov/criteria-air-pollutants/menu-control-measures-naaqs-implementation. Accessed: November 2017.

Abbreviations:

AQMD - air pollution control district
BACM - best available control measures
CFR - United States Code of Federal Regulations
ICAPCD - Imperial County Air Pollution Control District
NSPS - New Source Performance Standard
NAAQS – National Ambient Air Quality Standards
$PM_{2.5}$ – particulate matter less than 2.5 microns in diameter
ppm - parts per million
RACM - reasonable available control measure
SIP - State Implementation Plan
μg/m^3 - micrograms per cubic meter
USEPA - United States Environmental Protection Agency

APPENDIX D
SUPPORTING RULE AND CONTINGENCY EMISSIONS CALCULATIONS

Table D-1. Windblown Dust Emission Reductions from Rule 804 Contingency in the Imperial County $PM_{2.5}$ Nonattainment Area

Emission Factor for Windblown Dust [1]

Portion of Erosion Losses that Become Entrained TSP [1]	Soil Erodibility [1] (tons/acre/year)	Climatic Factor [1]	Surface Roughness Factor [1]	Unsheltered Field Width Factor [1]	Vegetative Cover Factor [2]	Dust Emission Factor (tons TSP/acre/year)
a	I	C	K	L'	V'	E_s
0.038	86	1.274	1	0.32	0.825	1.10

Emissions for Windblown Dust from Open Areas

Dust Emission Factor, E_s (tons TSP/acre/year)	Vacant Rural Lots ≤ 3 acres in $PM_{2.5}$ Nonattainment Area [3] (acres)	$PM_{2.5}$ Fraction of TSP [4]	$PM_{2.5}$ Emissions (tons/year)	$PM_{2.5}$ Emissions (tons/day)
1.10	529	0.0786	45.7	0.125

Mitigation of Emissions

$PM_{2.5}$ Emissions (tons/day)	Control Efficiency [5]	$PM_{2.5}$ Emission Reductions (tons/day)
0.125	70%	0.088

Notes:

[1] Methodology and certain parameters derived from California Air Resources Board's *Windblown Dust - Unpaved Roads.* August 1997. Available at: https://www.arb.ca.gov/ei/areasrc/fullpdf/full7-13.pdf. Accessed: March 2018.

[2] Parameter estimation based on method from USEPA's *Development of Emissions Factors for Fugitive Dust Sources*. Assumes an average vegetation of 250 pounds of air-dried residue per acre. June 1974. Available at: https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=2000MC6B.TXT. Accessed: March 2018.

[3] Acreage was calculated in ArcGIS using NAD 1983 California State Plane Zone V. Parcel data was obtained from the Imperial County Assessor and classified as Urban or Rural based on the Southern California Association of Governments 2010 census tract boundaries. Imperial County Nonattainment area GIS data was obtained from USEPA's Green Book. See Figure D-1.

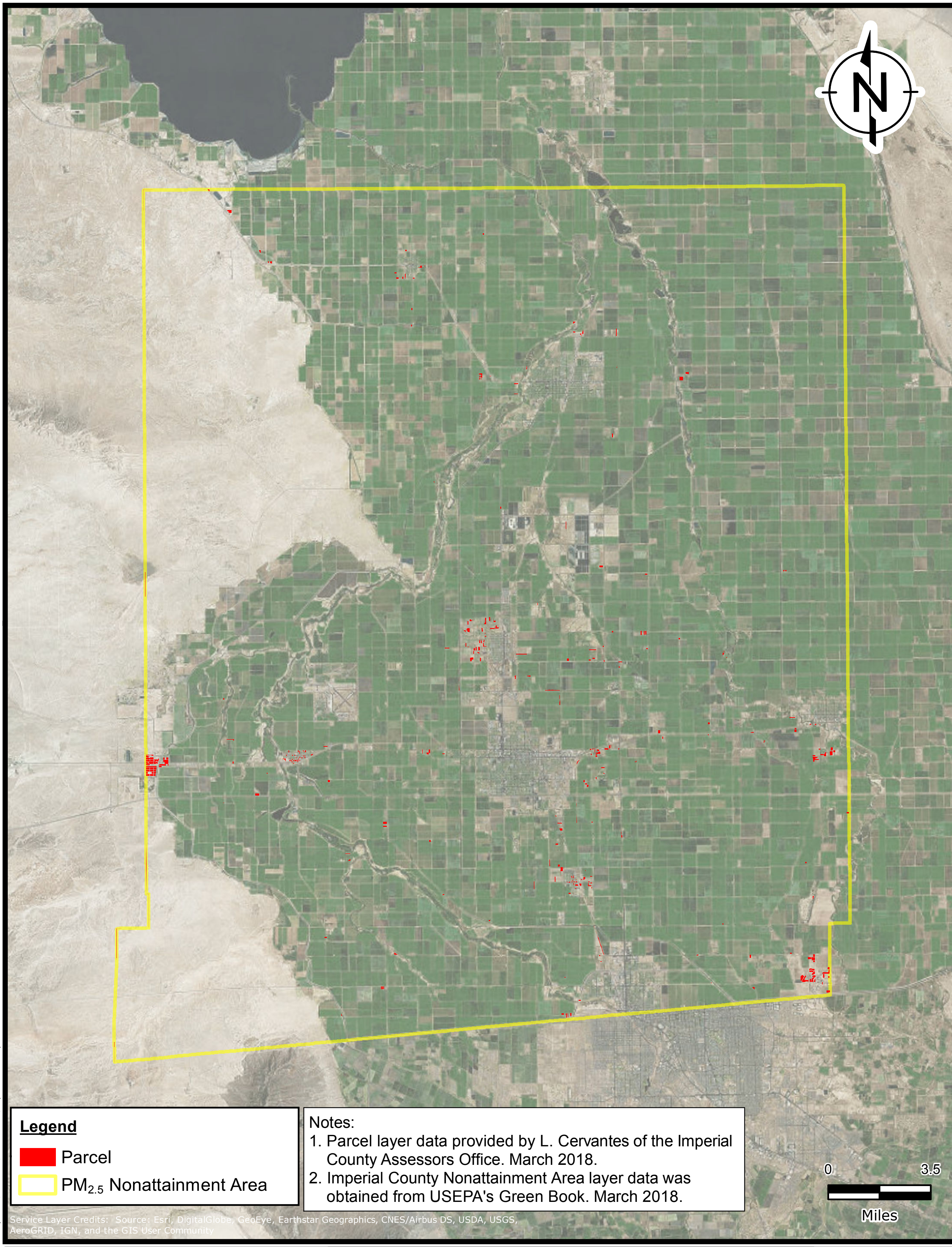
[4] Particle Size Fraction Data for Source Categories (PMSIZE link). Profile #416 (Windblown dust - Unpaved Roads/Area). California Air Resources Board. Available at: https://www.arb.ca.gov/ei/speciate/speciate.htm#specprof. Accessed: March 2018.

[5] Composite control factor based on an assessment of Rule 804 presented in Environ's *Draft Final Technical Memorandum - Regulation VIII BACM Analysis.* October 2005. Available at: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=7198. Accessed: March 2018.

Abbreviations:

TSP - total suspended particulate (i.e., particulate matter smaller than 30 microns in diameter)

$PM_{2.5}$ - particulate matter smaller than 2.5 microns in diameter



RAMBOLL

Vacant Rural Parcels Less than 3 acres in Size within the Imperial County PM$_{2.5}$ Nonattainment Area

FIGURE
D-1

DRAFTED BY: RC | DATE: 3/15/2018 | PROJECT: 1690003687

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Table D-2a. Wood Burning Curtailment Measure Emission Reductions

	PM$_{2.5}$ Emissions from Wood Burning			Units
	2020	**2021**	**2022**	
Imperial County Daily Winter Emissions				
Baseline Emissions	0.0708	0.0708	0.0708	tons/day
NSPS Certification Rule Reductions[1]	0.0024	0.0036	0.0049	tons/day
Net Emissions	0.0684	0.0672	0.0659	tons/day
Calexico Daily Winter Emissions				
Net Emissions[2]	0.0151	0.0148	0.0146	tons/day
Wood Burning Curtailment Rule				
Annual Reductions[3,4]	0.068	0.067	0.066	tons
Average Daily Reductions	**0.00019**	**0.00018**	**0.00018**	**tons/day**
Wood Burning Curtailment Contingency Measure				
Annual Reductions[4,5]	0.411	0.403	0.396	tons
Average Daily Reductions	**0.00112**	**0.00111**	**0.00108**	**tons/day**

Compliance Rate[4]: 75%

Percent of Imperial County Emissions in Calexico[2]: 22%

Notes:

[1] NSPS Certification Rule reductions based on a linear emissions reduction of 30% for wood stoves and 20% for fireplaces from 2019 through 2028 in the Imperial County PM$_{2.5}$ Nonattainment Area.

[2] Calexico daily winter emissions are estimated using the percent of Imperial County's total population in Calexico multiplied by the Imperial County winter emissions.

[3] Reduction from the wood burning curtailment measure is estimated as Calexico daily winter emissions multiplied by the average number of days which exceed 35 μg/m^3 during the curtailment period multiplied by an estimated compliance rate (See Table D-2b).

[4] A compliance rate of 75% is applied to the wood burning curtailment reductions. This is the same assumption used in the SCAQMD 2016 AQMP, Appendix VI-A.

[5] Reduction from the wood burning curtailment contingency measure is estimated as Imperial County daily winter emissions multiplied by the average number of days which exceed 30 μg/m^3 at the Calexico monitoring station during the curtailment period, multiplied by an estimated compliance rate (See Table D-2b). On days exceeding 35 μg/m^3, Calexico emissions are not included here as their reductions are already counted in the curtailment measure.

Abbreviations:

AQMP - Air Quality Management Plan

NSPS - New Source Performance Standard

PM$_{2.5}$ - particulate matter smaller than 2.5 microns in diameter

SCAQMD - South Coast Air Quality Management District

μg/m^3 - micrograms per meter cubed

Table D-2b. Average Threshold Exceedances based on 2014-2016 Winter Ambient Air Quality Monitoring Data

Wood Burning Curtailment Rule					
Year	Number of Days Exceeding Curtailment Rule Threshold[1] (days/year)				
	January	February	November	December	Total
2014	6	1	0	3	10
2015	2	0	0	1	3
2016	2	0	0	3	5
				Average	6.0

Wood Burning Curtailment Contingency Measure					
Year	Number of Days Exceeding Contingency Threshold and below Curtailment Rule Threshold[1] (days/year)				
	January	February	November	December	Total
2014	1	3	1	1	6
2015	0	0	0	0	0
2016	0	1	1	2	4
				Average	3.3

Curtailment Rule Threshold: 35 μg/m^3
Contingency Threshold: 30 μg/m^3

Notes:
[1] Count of number of days above threshold based on $PM_{2.5}$ ambient air quality monitoring data for the Calexico monitoring station, POC 1. Obtained from: https://www.epa.gov/outdoor-air-quality-data/download-daily-data. Accessed: November 2017.

Abbreviations:
$PM_{2.5}$ - particulate matter smaller than 2.5 microns in diameter
POC - point of collection
μg/m^3 - micrograms per cubic meter

APPENDIX E
AGRICULTURAL AND OPEN BURNING RULE COMPARISON

Table E-1. Agricultural and Open Burning California Air Districts Rules Comparison

Rule Number	Imperial County Rule 701	San Joaquin Valley APCD Rule 4103	South Coast AQMD Rule 444	Placer County APCD Rule 302	Monterey Bay Unified APCD Rule 438
Rule Title	**Agricultural Burning**	**Open Burning**	**Open Burning**	**Agricultural Waste Burning Smoke Management**	**Open Outdoor Fires**
Applicability	Regulates agricultural burning.	Regulates agricultural burning.	Regulates burning, disposal of Russian thistle, prescribed burning, fire prevention/suppression training, open detonation, and use of pyrotechnics and other fire hazards.	Regulates agricultural burning.	Regulates all burning including agricultural, prescribed, backyard, residential, and designated sensitive areas.
Burn Time Restrictions:	All burnings: daily, must be ignited between 10:00 a.m. and 3:00 p.m. and must be terminated by sunset.	• Field Crops: daily, must be ignited between 10:00 a.m. and 2:00 p.m. unless local conditions indicate that other hours are appropriate. • Agricultural waste: must burn during daylight hours; no waste shall be added to existing fires after 5:00 p.m.	• Field crops: daily, must be ignited between 10:00 a.m. and 5:00 p.m. • Non-field crops: daily, must not be ignited earlier than one hour after sunrise and must not be ignited or have fuel added later than two hours before sunset.	• Field crops: daily, must be ignited between 10:00 a.m. and 5:00 p.m. • The District may further restrict burning hours if it is deemed necessary to prevent adverse impacts to downwind receptors.	• Field Crops: daily, must be ignited between 10:00 a.m. and 5:00 p.m. unless local conditions indicate that other hours are appropriate.
Drying Duration	• Trees/large branches: 6 weeks • Green field stubble: 4 days following harvest • Prunings and small branches: 2 weeks • Dry cereals: 0 days	• Trees/large branches: 6 weeks • Prunings and small branches: 3 weeks • Spread rice straw: 3 days (if straw does not make audible crack) • Rowed rice straw: 10 days (if straw does not make audible crack)	• Trees/large branches: 6 weeks • Prunings and small branches: 4 weeks • Green waste from field crops: 4 weeks • Fine fuels: 3 weeks • Very fine fuels: 10 days	• Trees/large branches (>6 in. diameter): 6 weeks • Prunings and small branches (3-6 in. diameter): 3-6 weeks • Fine prunings/cuttings (<3 in. diameter):15 days • 3-6 weeks for prunings and small branches • Green waste from field crops: 3 days • Spread rice straw: 3 days • Rowed rice straw: 10 days	• Tree stumps (>6 in. diameter): 180 days • Green waste from field crops: 10 days • Trees, branches, and prunings (>2 in. and <6 in. diameter): 60 days • Trees, branches, and prunings (<2 in. diameter): 30 days
Administrative Requirements	Permit and notice of intent required for agricultural burning.	Permit required for open burning.	• Permit and Burn Authorization Number required for open burning. • Burn Management Plan required for projects greater than 10 acres or that produce more than 1 ton of PM emissions per AP-42 methodology. • Annual Post Burn Evaluation Report required for projects requiring Smoke or Burn Management Plans.	Permit required for agricultural burning.	Permit required for open burning.
Burning Requirements and Prohibitions	• Waste must be arranged in such manner as to promote drying and insure combustion with a minimum of smoke production. • Waste must be free of tires, rubbish, tar paper, construction debris, and other non-agricultural materials, as well as excessive dirt, soil, and moisture. • Additional requirements for burning within 1.5 miles of a residential area, rural school, or adjacent to heavily traveled roads. • Additional requirements for burning near large amounts or near residential areas.	• No burning of petroleum wastes, demolition/construction debris, residential rubbish, garbage, vegetation, tires, tar, trees, wood waste, combustible/flammable materials, motor vehicle bodies, or burning for metal salvage. • No burning of certain field crops, prunings, weeds for abatement, orchard removals, vineyard removal materials, or surface-harvested prunings. • Agricultural waste shall not be burned unless it is arranged or loosely stacked in such a manner as to promote drying and insure combustion with a minimum of smoke production, and also must be free of excessive dirt, soil, and visible surface moisture, as well as items such as plastic, rubber, ornamental or landscape vegetation, shop wastes, construction/demolition material, garbage, oil filters, broken boxes, pallets, sweat boxes, packaging material, packing boxes, and pesticide/fertilizer containers. • No burning of orchard/vineyard removal waste or other material generated as a result of land use conversion from agricultural to non-agricultural.	• Burning may only occur on "permissive burn days" or "marginal burn days". • Open burning prohibited for residential burning, disposal of waste, suppression of wildland fires, burning of existing structures firefighting training purposes, or vegetative waste that has been transported from one property to another. • Agricultural waste must be free of dirt, soil, and visible moisture and requires a Burn Management Plan. • Prescribed burning requires a Smoke Management Plan.	• Waste must be free of dirt, soil, and surface moisture and burned in a way to prevent excessive smoke. • No burning of disallowed combustibles. • Additional requirements for burning near large amounts or near residential areas.	• Open burning prohibited for residential burning, disposal of petroleum waste, construction debris, tires, tar, trees, household rubbish, plastics, wood waste, processed or treated wood products, garlic tops, combustible/flammable materials, motor vehicle bodies, or for metals salvage. • Waste must be free of dirt, soil, and surface moisture and burned in a way to prevent excessive smoke. • No use of burn barrels unless authorized by local fire agency. • No burning of materials containing poison oak where the smoke could adversely affect nearby residences • No burning when the wind direction would blow smoke toward a smoke sensitive area. • Prescribed burning requires a Smoke Management Plan, daily authorization from the District, and public notification and cannot occur on poor air quality days or exceed daily emissions allocations. • Additional requirements apply towards forest and wildland vegetation management activities.
Prohibition of Burning Causing a Nuisance?	Yes	Yes	Yes (beach burning devices only)	Yes	Yes