Northern Sierra Air Quality Management District

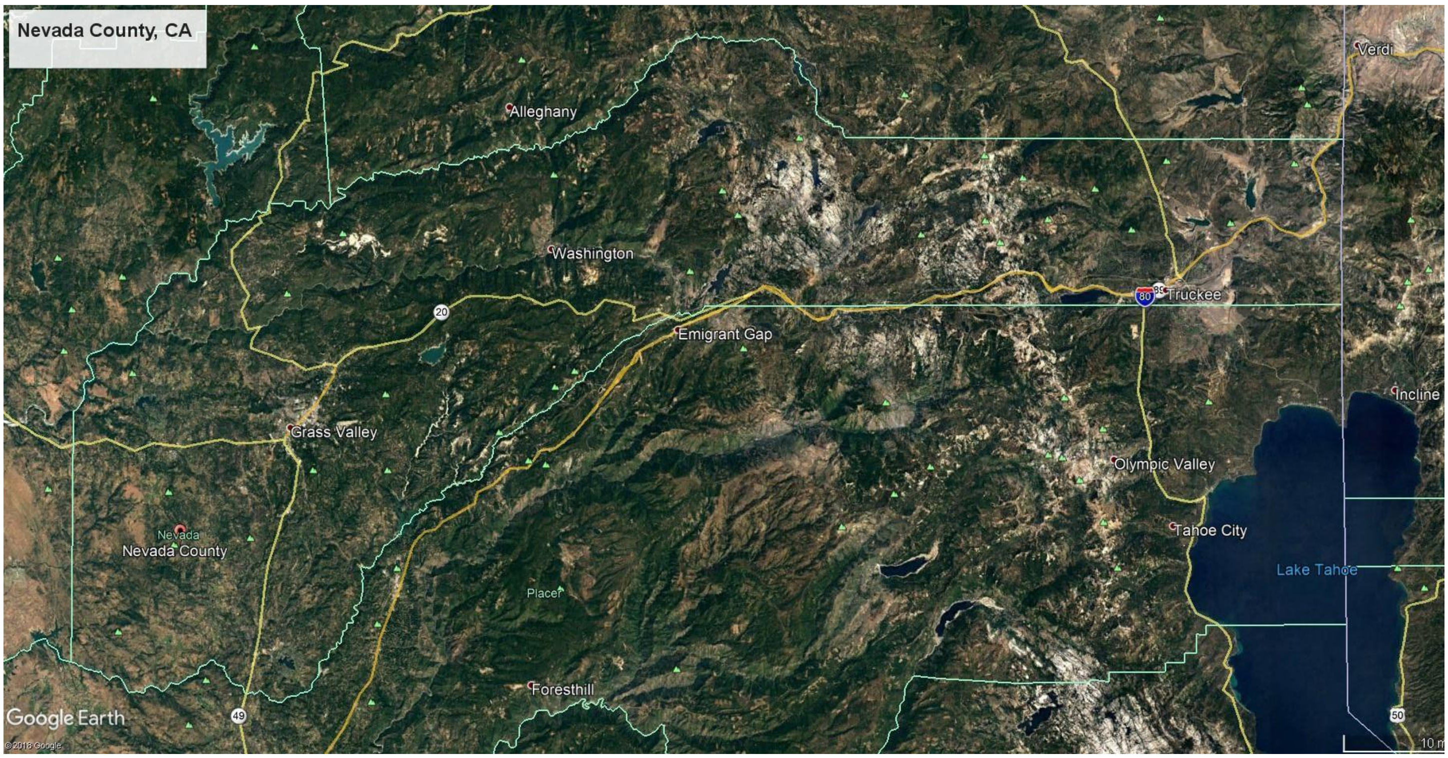


Image from Google Earth, 8/28/18

Ozone Attainment Plan
Western Nevada County

State Implementation Plan for the 2008 Primary Federal 8-Hour Ozone Standard of .075 ppm

Proposed for Adoption October 22, 2018

TABLE OF CONTENTS

Page

EXECUTIVE SUMMARY 6

I. INTRODUCTION 7
- A. Ozone 7
- B. Background 7
- C. Nevada County Split 8
- D. 1997 8-Hour NAAQS 8
- E. 2008 8-Hour Standard 9

II. CHALLENGES 10
- A. Meteorology 10
- B. Geography 11
- C. Pollutant Transport and Scavenging 12
- D. Ozone Trends 16
- E. Biogenic Emission Inventory 17
- F. Progress 17

III. SERIOUS NON-ATTAINMENT RECLASSIFICATION REQUEST 20

IV. EMISSIONS INVENTORY BACKGROUND 21
- A. Emissions Inventory 21
- B. Emissions Inventory Overview 21
- C. Agency Responsibilities 22
- D. Inventory Base Year 22
- E. Forecasted Inventories 22
- F. 2011 Baseline Year Inventory for Reasonable Further Progress 23
- G. Temporal Resolution 23
- H. Geographical Scope 23
- I. Quality Assurance and Quality Control 25

V. SUMMARY OF EMISSIONS INVENTORY METHODOLOGIES 26
- A. Point Sources 26
- B. Areawide Sources 28
- C. Point and Areawide Source Emissions Forecasting 30
- D. Stationary Source Control Profiles 31
- E. Mobile Sources 32
- F. On-Road Mobile Sources 32
- G. Off-Road Mobile Sources 33
- H. Mobile Source Forecasting 34

VI. TRANSPORTATION CONFORMITY BUDGETS 36
- A. Requirements for Demonstrating Conformity 36
- B. Conformity Budgets in the 2018 Ozone Attainment Plan 37
- C. Banked Emission Reduction Credits 38

VII. EMISSION STATEMENT RULE 39

VIII. NEW SOURCE REVIEW 40

IX. SERIOUS NON-ATTAINMENT PLAN REQUIREMENTS 41

X. REASONABLE AVAILABLE CONTROL MEASURES DEMONSTRATION 42
A. RACM for Stationary Sources 42
B. RACM for Mobile Sources 50
C. RACM for Areawide Sources 51
D. RACM Conclusion..52

XI. REASONABLE FURTHER PROGRESS (RFP) 54

XII. ATTAINMENT DEMONSTRATION 56

XIII. CONTINGENCY MEASURES 60

XIV. CONCLUSION 61

FIGURES

Figure 1: California Air District Map...4
Figure 2: NSAQMD and Non-attainment Boundaries 5
Figure 3: Monthly Average of Daily 8-hour Ozone Maximums, Grass Valley, 2017 .11
Figure 4: Transport Corridors & Wind Flow Patterns...13
Figure 5: Grass Valley Ozone Concentrations by Hour of Day, May 1 – September 30, 2017...14
Figure 6: Summer Ozone Precursor Emissions – Western Nevada County, San Francisco Bay Area and Sacramento Non-Attainment Area 15
Figure 7: Grass Valley Ozone Concentrations by Hour of Day, May-October, 2017 .16
Figure 8: Federal 8-Hour Ozone Design Values 17
Figure 9: Western Nevada County Design Value Trend, 2000 – 2017........................18
Figure 10: Emissions Inventory Overview...53

TABLES

Table 1: Method for the Spatial Allocation of Emissions to the Western Nevada County Ozone Non-attainment Area 24
Table 2: Point Source Categories..26
Table 3: Areawide Sources 28
Table 4: Growth Surrogates for Point and Areawide Sources 30
Table 5: District and CARB Stationary Source Control Rules and Regulations Included in the Inventory 32
Table 6: Growth Surrogates for Mobile Sources 34

Table 7: Transportation Conformity Budgets for the 2008 8-hour Ozone standard in the Western Nevada County Ozone Nonattainment Area, tons per average summer day. 38
Table 8: CTG Summary Table Indicating NSAQMD's RACT Actions and Negative Declarations for the 2008 NAAQS 42
Table 9: Projected Daily Emissions 2020 versus 2021 (Summer) 52
Table 10: Western Nevada County 75 ppb 8-hour Ozone Reasonable Further Progress (summer planning inventory, tons per day) 55
Table 11: Summer emission inventory totals (CEPAM v1.03) for 2012 and 2020. Biogenic emission totals were averaged over May – September 2012 57
Table 12: Baseline Design Value, modeled RRF, and projected future year (2020) 8-hour ozone Design Values (DV) at the Grass Valley ozone monitoring site in WNNA 58
Table 13: Projected VOC and NOx Emissions from 2020 to 2021 60

APPENDICES

Appendix A: Emission Inventories for 2011, 2012, 2014, 2017, 2020 & 2021 .... A-1

Appendix B: CARB Control Measures, 1985 to 2016 ....B-1

Appendix C: CARB Analyses of Key Mobile Source Regulations & Programs Providing Emission Reductions C-1

Appendix D: Reasonably Available Control Measures Assessment for Mobile Sources and Consumer Products D-1

Appendix E: Modeling Attainment Demonstration E-1

Appendix F: Modeling Emission Inventory for the 8-Hour Ozone State Implementation Plan in Western Nevada County Non-attainment Area (WNNA) F-1

Appendix G: Western Nevada County Non-attainment Area (WNNA) for the 2008 NAAQS 8-hour Ozone Standard of 0.075 ppm (2018) G-1

Appendix H: Photochemical Modeling Protocol: Photochemical Modeling for the 8-Hour Ozone and Annual/24-hour PM2.5 State Implementation Plans H-1

Figure 1: California Air District Map.

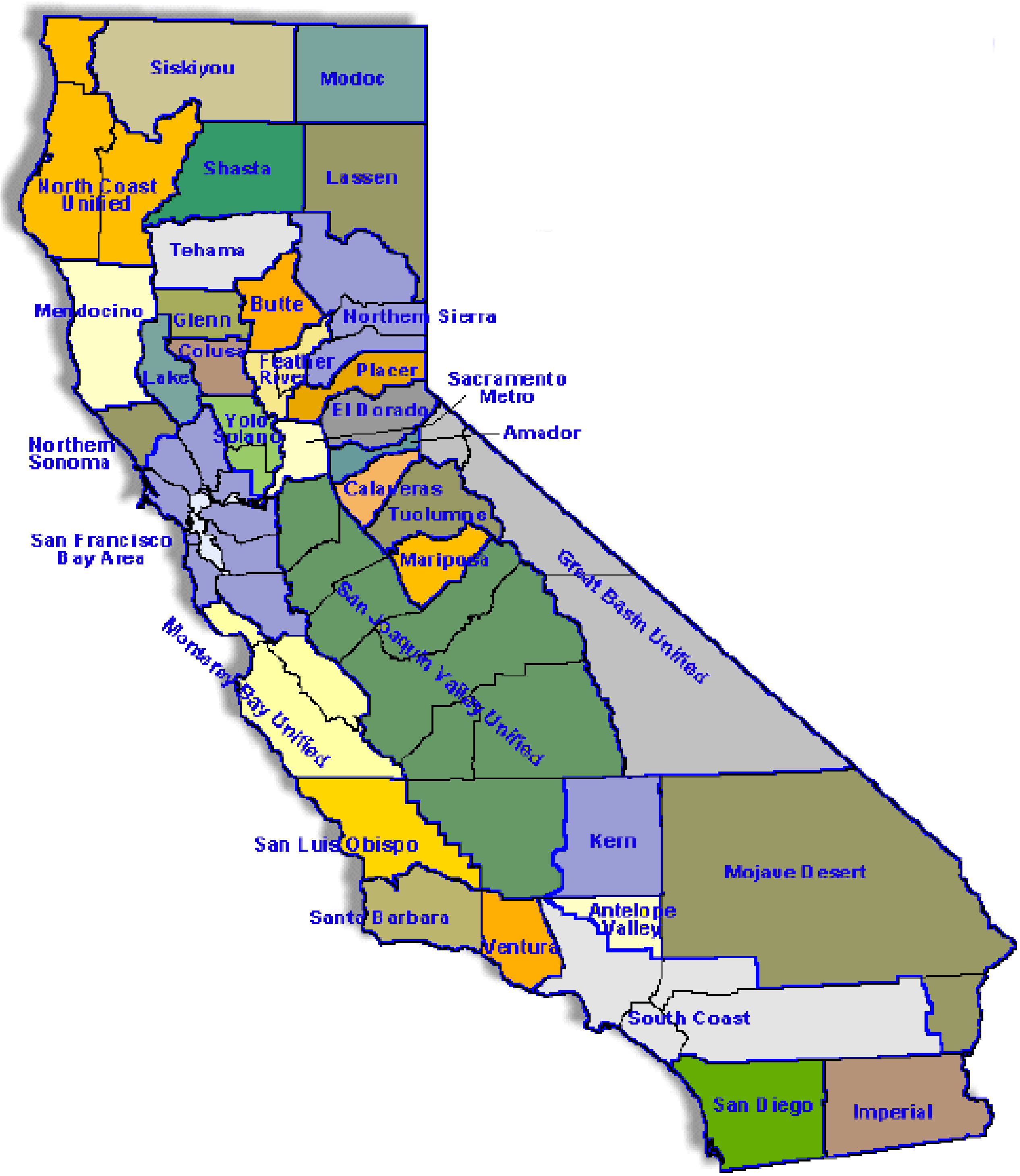
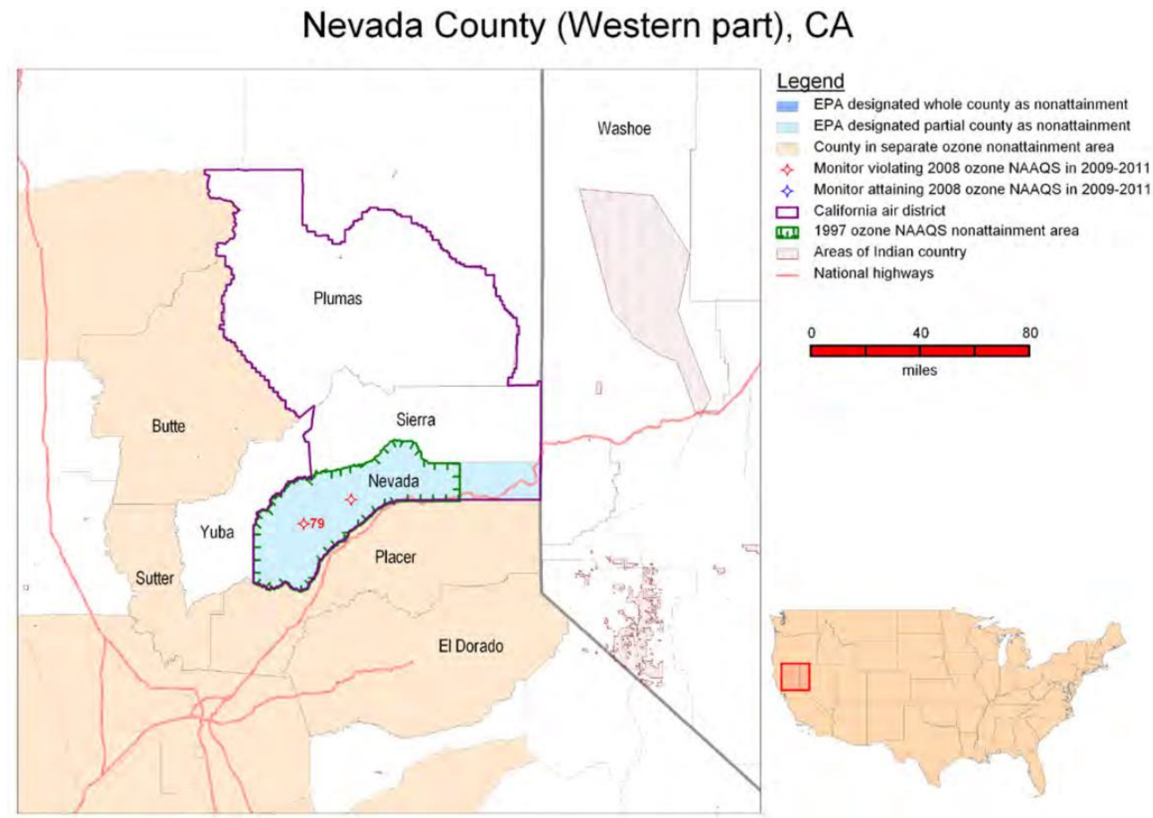


Figure 2: Non-attainment Area (With Initial Designation Design Value).



Source: Technical Support Document for 2008 Ozone NAAQS Designations, Technical Analysis for Nevada County (Western part), EPA https://www3.epa.gov/region9/air/ozone/pdf/R9_CA_NevadaCounty_FINAL.pdf, extracted 2/7/2018.

EXECUTIVE SUMMARY

This State Implementation Plan (SIP) revision is being submitted by the Northern Sierra Air Quality Management District (District or NSAQMD) to the U.S. Environmental Protection Agency (EPA) to fulfill requirements under the federal Clean Air Act (CAA) that result from Western Nevada County being designated as Non-attainment for the 2008 8-hour Ozone National Ambient Air Quality Standards (NAAQS). The Northern Sierra Air Quality Management District includes the California counties of Nevada, Sierra and Plumas. In 2012, the Western Nevada County portion of the District was designated and classified "Marginal" Non-attainment for the 2008 8-hour NAAQS of 0.075 ppm. Since the area did not meet the standard, it was "bumped up" to a "Moderate" Non-attainment area, effective June 2016. With this SIP revision, the area is requesting, out of necessity, to bump up again to a "Serious" Non-attainment classification (the next highest classification above Moderate), and has structured this SIP revision to meet the CAA's Serious level requirements.

The California Air Resources Board (CARB) has conducted photochemical modeling, along with supplemental analyses, to find out when the Western Nevada County Non-attainment Area (WNNA) could attain the 2008 Ozone NAAQS. The results indicated the District could attain the 0.075 ppm standard by the Serious non-attainment area deadline of 2021. Pursuant to Section 181(b)(3) of the CAA, "Voluntary Reclassification," the District requests CARB to formally submit a request to EPA asking for voluntary reclassification of the WNNA from "Moderate" to "Serious" Non-attainment for the 2008 8-hour Ozone NAAQS, and revise the attainment date to December 31, 2021 (based on 2018-2021 data).

The District expects EPA to approve the request to be reclassified as Serious non-attainment, and this ozone attainment plan addresses all required Serious level elements, emissions reductions, and control measures necessary to demonstrate attainment with the 2008, 8-hour Ozone NAAQS by 2021.

I. INTRODUCTION

A. Ozone

Stratospheric ozone occurs naturally and is beneficial in the upper atmosphere, shielding the earth from harmful ultraviolet radiation from the sun. However, ground-level (tropospheric) ozone (O_3) is a highly reactive, strongly oxidizing, colorless gas that can damage living tissues, vegetation and man-made materials upon contact.

O_3 is not directly emitted from sources, but is formed in the air by reactions of O_3 precursor emissions—volatile organic compounds (VOC) and oxides of nitrogen (NOx)—in the presence of sunlight and heat. Accordingly, peak O_3 levels occur during the sunnier, warmer times of the year, typically May through October.

Health effects of O_3 are focused on the respiratory tract. When inhaled, O_3 can irritate and inflame the lining of the lungs, much like sunburn damage on skin. Potential health impacts include aggravated asthma, reduced lung capacity, and increased susceptibility to respiratory illnesses like pneumonia and bronchitis. Individuals with compromised respiratory function are most vulnerable to O_3, but outdoor activities on "high" O_3 days can affect people who are normally healthy.

B. Background

The Federal Clean Air Act (FCAA) of 1970 requires the United States Environmental Protection Agency (EPA) to develop health-based National Ambient Air Quality Standards (NAAQS) for several categories of air pollutants, including ozone (O_3). EPA periodically reviews the NAAQS and associated scientific basis in determining appropriate revisions. Accordingly, EPA establishes new standards in response to advances in scientific understanding of ozone and its health effects.

Section 110 (a)(1) of the Federal Clean Air Act Amendments (FCAAA) of 1977 required EPA to divide the United States into "Planning Areas" and designate these areas "attainment," "non-attainment" or "unclassified." In 2015, EPA promulgated an "implementation" rule for the 2008 8-hour ozone NAAQS (2015 Implementation Rule) [1], designed to assist states with plan development. Under the Implementation Rule, affected regions are required to address planning and emission control requirements in their implementation plan.

The FCAAA of 1990 gave states the primary responsibility for achieving the NAAQS. The principal mechanism for complying with the FCAAA was developing and adopting a State Implementation Plan (SIP). A SIP outlines programs, actions, and commitments a state will carry out to implement its responsibilities under the FCAAA. The EPA must approve all SIPs before they can be implemented by state and local governments. Once

[1] Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements; Final Rule. 80 Fed. Reg. 44. Pp. 12264-12319. (March 6, 2015), (to be codified at 40 CFR Parts 50, 51, 52, et al.) https://www.gpo.gov/fdsys/pkg/FR-2015-03-06/pdf/2015-04012.pdf

approved by the EPA, a SIP becomes a legally binding document under both state and federal law, and may be enforced by either governmental body.

All non-attainment areas classified Moderate Non-attainment and higher, including Western Nevada County, are subject to the general planning and emission control requirements of Subpart 2 (Title I, Part D) of the CAA, which include an emission inventory, a New Source Review rule and an Emissions Statements Rule.

C. Nevada County Split

Nevada County spans the Sierra Nevada mountain range. The Town of Truckee is near the eastern boundary, east of the Sierra crest, and has very different weather from western Nevada County. Historical ozone data from Grass Valley (in western Nevada County) and Truckee show that there is no clear connection between conditions on the east side and the west side of the Sierras, with ozone concentrations almost always being much lower on the east side. Therefore, EPA limited its non-attainment designation to the western portion of the County. The dividing line runs north/south near the Sierra crest, less than a mile east of the town of Soda Springs.

The District worked with CARB to separate the Nevada County emissions inventory into an eastern and western portion, along the Non-attainment Area boundary. More than 80% of the County's population and emissions is in the western, non-attainment portion to which this SIP revision applies.

D. 1997 8-Hour NAAQS

The NAAQS was revised in 1997 to an 8-hour O_3 concentration of 0.08 ppm. The 8-hour averaging time was selected to address the impacts of exposure to longer periods of elevated O_3. The 0.08 ppm O_3 standard is attained when: Each monitor in a region shows a three-year O_3 concentration average, of the annual fourth-highest daily 8-hour average, no greater than 0.084 ppm (based on the rounding convention dictated in federal regulation)[2]. Three years of O_3 concentrations are averaged due to the impacts of year-to-year variations in meteorology on O_3 formation.

The Western Nevada County portion of the District was designated in 2004 by EPA as a Non-attainment Area for the national 1997 NAAQS of 0.080 parts per million (ppm), pursuant to the CAA. By 2011, the Design Value[3] of the District's Ozone Non-attainment Area had dropped from 0.098 ppm (2003 level) to 0.079 ppm. On December 3, 2012, EPA published a Determination of Attainment for the WNNA for the 1997 8-hour O_3 NAAQS.[4] With this finding, effective January 2, 2013, Western Nevada County

---

[2] Appendix I to 40 CFR 50, "Interpretation of the Eight-Hour Primary and Secondary National Ambient Air Quality Standards for Ozone."

[3] The three year average of the fourth highest 8-hour ozone value for the target year and the two preceding years is the design value for that year. To determine attainment that design value is compared to the Ozone NAAQS.

[4] 77 Federal Register 71551-71555; December 3, 2012

was deemed to have "clean data" with respect to the 1997 standard, which suspended numerous CAA planning requirements for that standard.

E. 2008 8-Hour Standard

In 2008, EPA adopted a more stringent 8-hour ozone NAAQS of 0.075 ppm[5]. Although Western Nevada County showed a significant reduction in O_3 levels through data meeting the 1997 O_3 NAAQS, the area had a Design Value[6] higher than the new standard. On May 21, 2012, EPA classified the Western Nevada County portion of the District as "Marginal" non-attainment for the 2008 O_3 NAAQS.

CARB, in partnership with the District, conducted photochemical modeling along with supplemental analyses to determine anticipated attainment of the 2008 O_3 NAAQS. Air monitoring data and modeling revealed the District's would not attain the standard by the Marginal (July 15, 2015) or Moderate (January 1, 2017) deadline. However, modeling indicates the District could attain the 2008 O_3 NAAQS by the "Serious" classification deadline of December 31, 2020. Therefore, this attainment plan addresses all required elements for a "Serious" non-attainment O_3 plan and identifies emissions control measures and associated emission reductions necessary to demonstrate attainment by 2020.

[5]73 FR 16436; 40 CFR 50.15, "National Primary & Secondary Ambient Air Quality Standards for Ozone."
[6]Attainment is achieved when: "3-year average" of "annual 4th highest daily maximum" 8-hour average O_3 concentration, called "Design Value", is no greater than 0.075 ppm at each EPA-approved O_3 air monitor in the District. The "3-year & 4th highest" are statistical values that provide stability to the standard, moderating the influence of extreme meteorological conditions (over which an area has no control).

II. CHALLENGES

A. Meteorology

The predominant wind direction in western Nevada County, especially during the summer months, is from southwest to northeast. This pattern is conducive to transport of pollutants from the Bay Area and the Sacramento Area into Nevada County. On most summer mornings the "delta breeze" moves from the Carquinez strait northeast towards Sacramento and then veers northward and continues into the northern Sacramento Valley and into the foothills of the northern Sierra Nevada, including Western Nevada County. High ozone days are typically associated with light to moderate winds blowing from the direction of Sacramento. In the absence of a significant weather system affecting the area, summertime winds in Nevada County typically flow up-slope in the daytime and down-slope at night (referred to as diurnal flow).

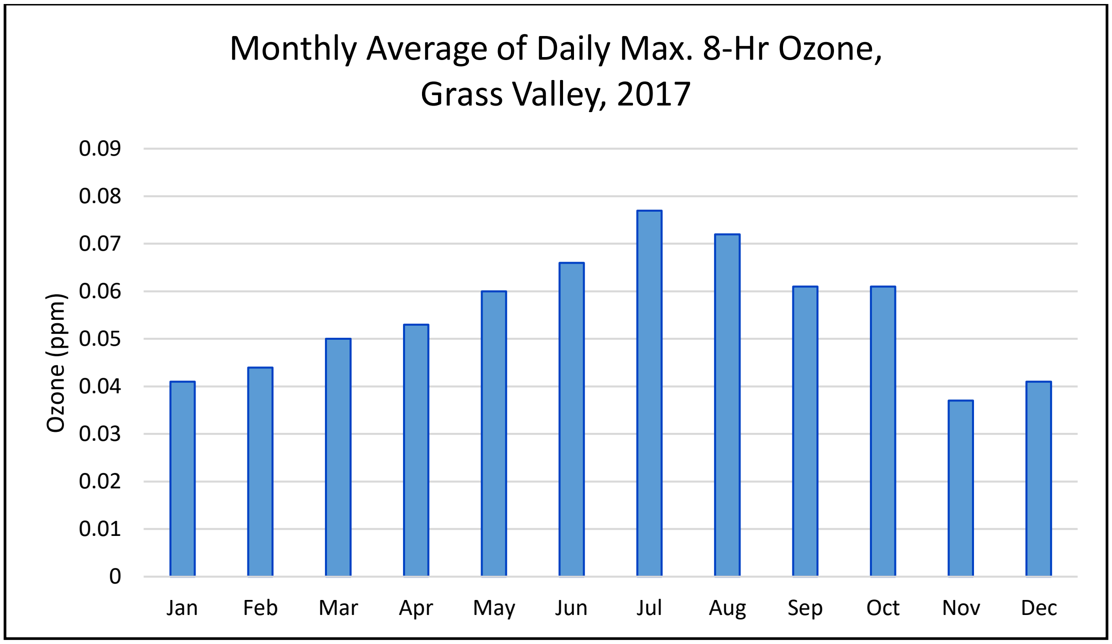
Most ozone exceedances happen on hot, dry, clear afternoons and evenings. High summer temperatures and low relative humidity play a big role in O_3 formation. Sunlight is another factor, with exceedance days being relatively concentrated in the long, clear days of June through August. The combination of a hot, dry summer and little to no cloud cover favor photochemical O_3 formation.

As a result of conditions encouraging ozone formation and the transport of both ozone and ozone precursors from upwind metropolitan areas, O_3 concentrations tend to be the highest in July and August.

Figure 3 shows the monthly average of daily maximum 8-Hr Average O_3 concentration during 2017, measured at the District's Grass Valley[7] air monitoring site. O_3 concentrations gradually rise from the beginning of the year toward the summer where levels peak in July and August when temperatures are usually the hottest, then decline during the fall.

[7] Data obtained from NSAQMD maintained Ozone monitoring site at 200 Litton Drive in Grass Valley.

Figure 3: Monthly Average of Daily 8-hour Ozone Maximums, Grass Valley, 2017.



B. Geography

The Western Nevada County Non-attainment Area is located in northern California's Sierra Nevada foothills. Although the Non-attainment Area is relatively small (802.41 square miles), it rises from near 300 feet AMSL in the west to over 9,000 feet AMSL near the eastern boundary. The eastern boundary is a line running north/south that more or less follows rugged mountain tops that form the "Sierra Crest." The line crosses I-80 slightly east of the town of Soda Springs. The Non-attainment Area is bordered on the north by the Middle Yuba River and is bisected by the South Yuba River. Most of the southern border is defined by the Bear River. The massive scenic canyons created by these rivers run predominantly east/west and are more than 2,000 feet deep in some places.

The WNNA ozone monitor is located at an elevation of approximately 2,860 feet, in the City of Grass Valley. Only 5 miles northwest of the monitor (along the South Yuba River) the elevation is 1,725 feet lower, and 12 miles south (along the North Fork of the American River) the elevation is 1,700 feet lower. Much of the western edge of the WNNA is below 500', a difference of 2,300 vertical feet from the monitor. 1.5 miles NW of the monitor, the elevation is 700 feet lower. Fewer than 5 miles NE of the monitor, on Banner Mountain, the elevation climbs another 1,000 feet. Downtown Grass Valley, the WNNA's biggest city (2016 Census Bureau estimated population 12,934), is approximately 1 mile SW from the monitor and 400 feet lower. This complex topography can cause unpredictable air movement as different slopes warm and cool at different rates. The river canyons' profound effects on tropospheric air flow have historically introduced significant uncertainty into dispersion modeling.

Western Nevada County is northeast and generally downwind from the Sacramento Non-attainment Area. To the north is the unmistakably rural County of Sierra (2010 census population: 3,240). To the south is Placer County, and to the immediate west is largely agricultural Yuba County.

C. Pollutant Transport and Scavenging

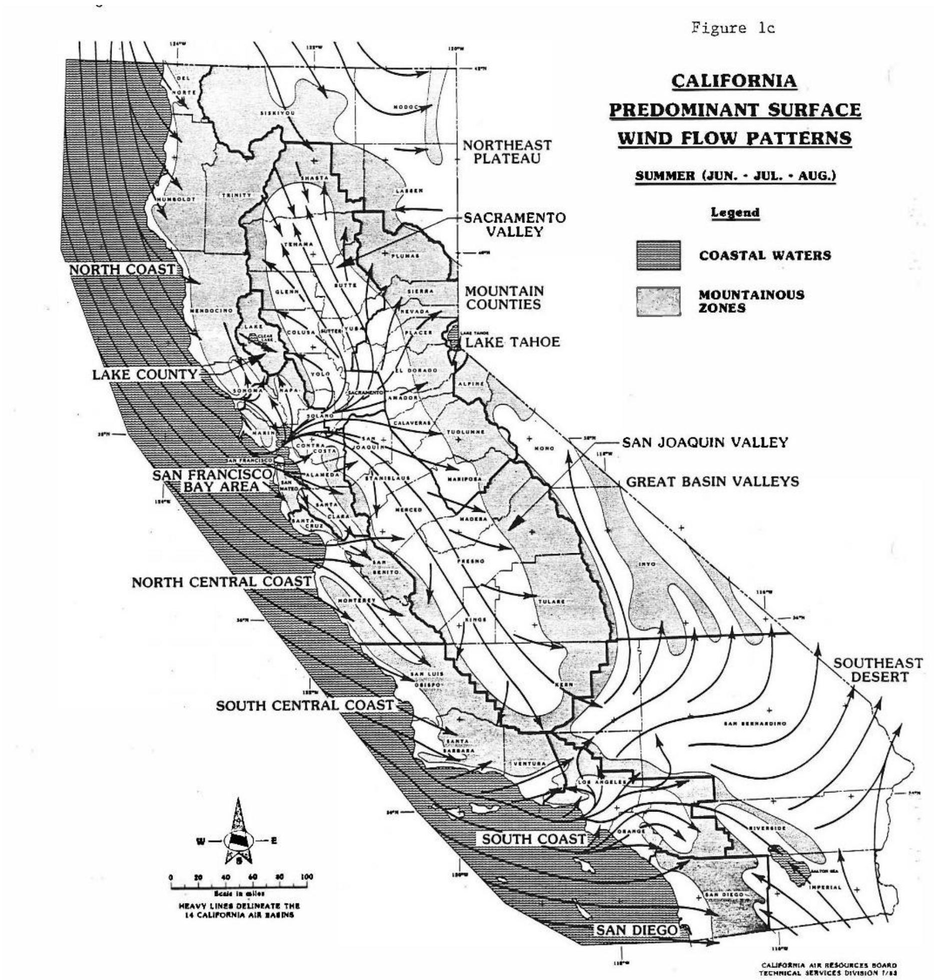
It is common for air pollutants to be transported by wind between air basins. The District's air quality is overwhelmingly impacted by O_3 and its precursor emissions being transported from the Sacramento Non-attainment Area (classified Extreme Non-attainment) and to a lesser extent from the San Francisco Bay Area. Transport can take place from the surface up to several thousand feet elevation. Transport occurs when winds are of sufficient magnitude, direction, and duration. Atmospheric chemistry also determines how transported pollutants may affect downwind O_3 concentrations.

Approximately 83,000 of Nevada County's 100,000 people (population 99,814 estimated by the Census Bureau as of 7/1/17) live in the WNNA. The WNNA's population is relatively dispersed, with approximately 103.4 people per square mile (6.19 acres per person).

Analyses of wind and ozone data from the Sacramento area and western Nevada County demonstrate that O_3 and its precursors transport to the District when prevailing wind originates from consistently high O_3 concentration areas, and wind is persistent with high enough velocity to move emissions from upwind areas. Data also demonstrate elevated O_3 concentrations in the District coinciding with high upwind O_3 levels. Figure 4 illustrates regional transport corridors and wind flow patterns[8].

[8] From Hayes, T.P., J.J. Kinney, and N.J. Wheeler, 1984. California Surface Wind Climatology, 1984. Published by the California Air Resources Board. https://www.arb.ca.gov/research/apr/reports/l013.pdf

Figure 4: Transport Corridors & Wind Flow Patterns.

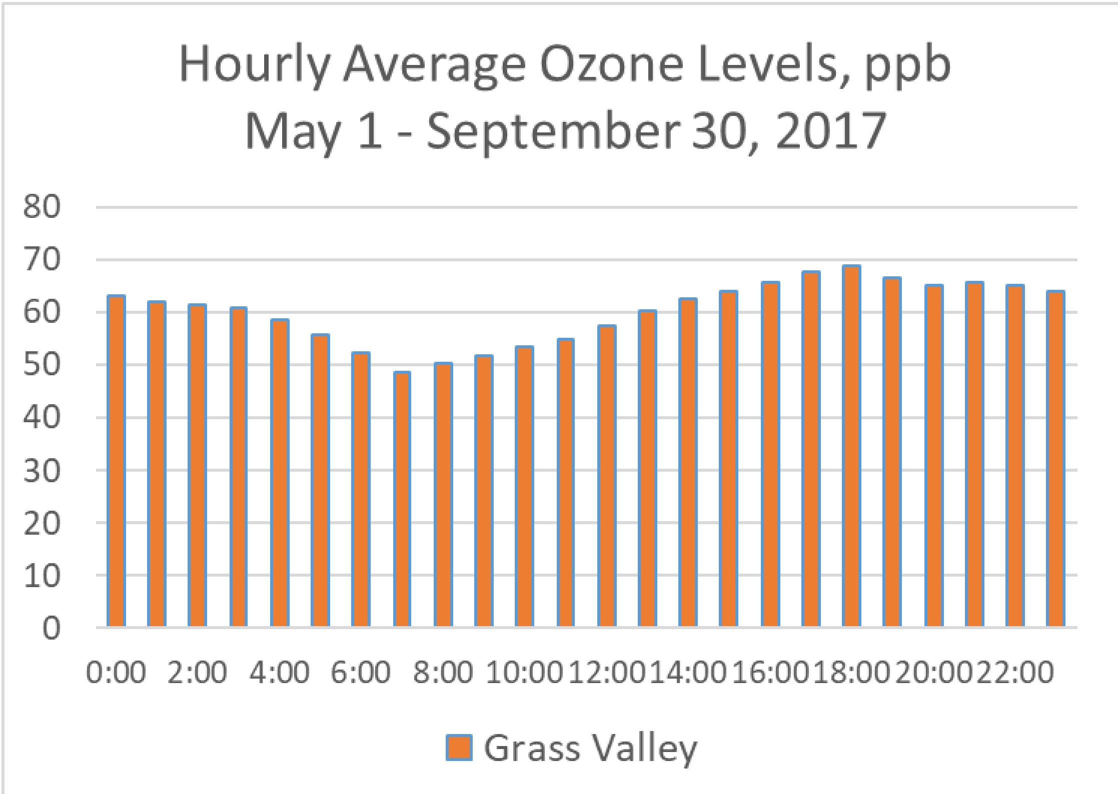


A widely accepted concept in ozone science is “nighttime NOx scavenging.” In the absence of sunlight, new ozone is not formed and NOx molecules are able to react with ozone and steal one of its oxygen atoms, resulting in an oxidized NOx molecule and normal, relatively unreactive oxygen (O_2).

NOx scavenging is thought to be largely responsible for the typical sharp drop-off of ozone concentrations in urban areas when the sun goes down. Urban areas generally have substantial NOx emissions after dark, primarily from motor vehicles and industrial processes. However, western Nevada County has relatively little traffic after dark and no significant stationary nighttime NOx sources.

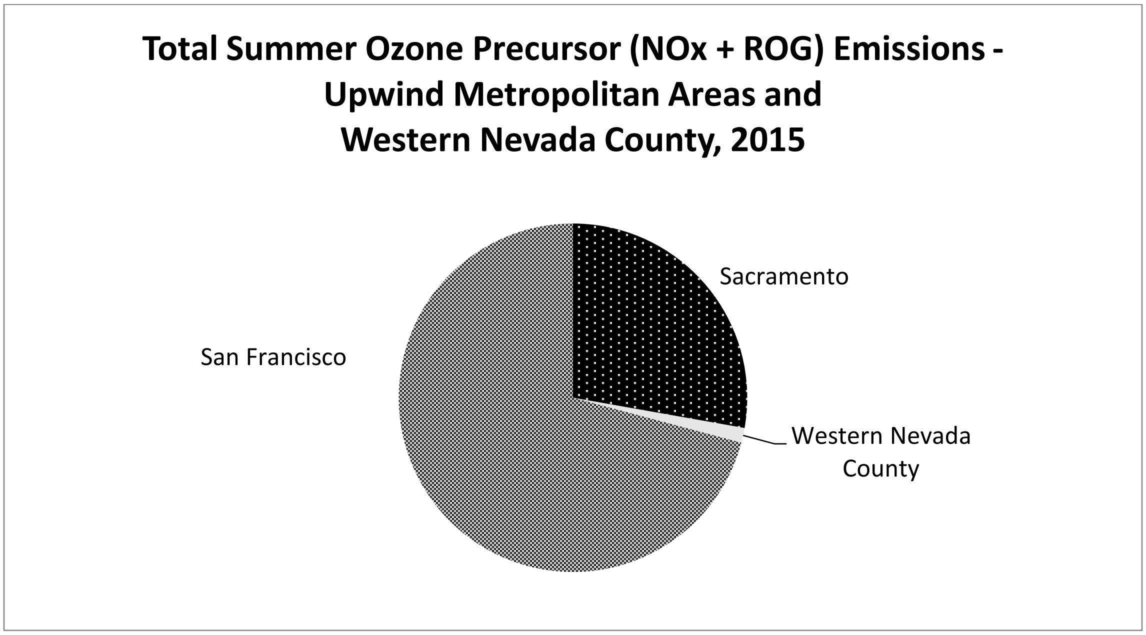
Figure 5 illustrates 2017 ozone values by time of day. It is apparent that the drop in ozone overnight is not substantial.

Figure 5: Grass Valley Ozone Concentrations by Hour of Day, May 1 – September 30, 2017.



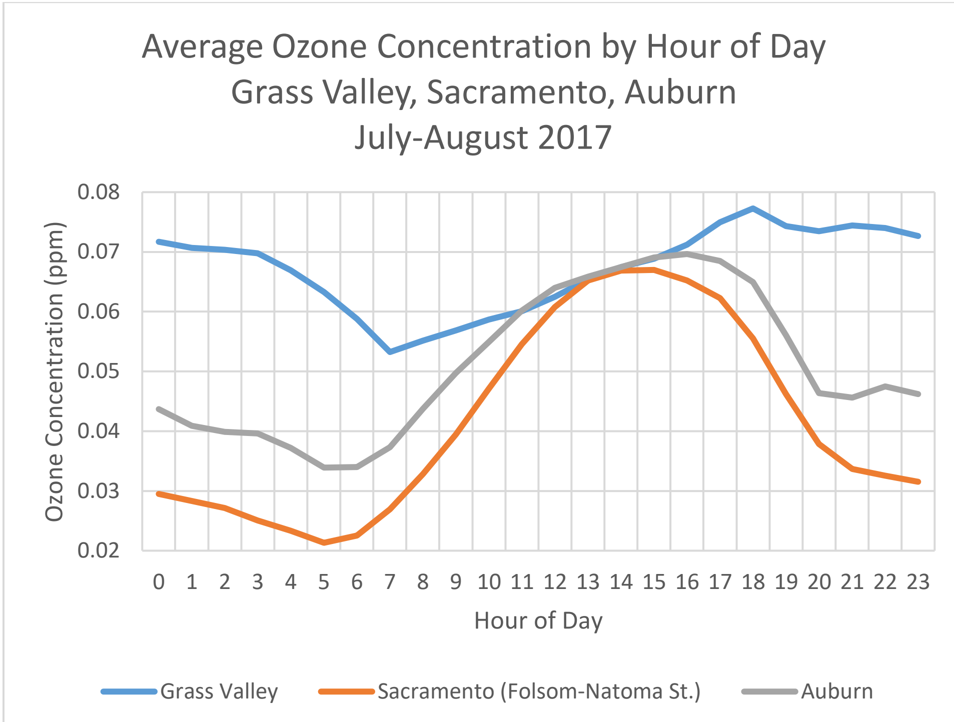
The sheer quantity of emissions in the upwind metropolitan areas compared to western Nevada County works with the transport mechanisms to overwhelm the latter (see Figure 6). Western Nevada County's summer emission inventory is miniscule (less than 9 tons per day of ozone precursors, with well under a ton of that coming from stationary sources, according to the most recent CEPAM 2015 inventory data from CARB). The area is a rural, downwind receptor of ozone generated in upwind major metropolitan areas (primarily the Sacramento Non-attainment Area with 180 tons per day and the San Francisco Bay Area with 458 tons per day). Figure 5 provides perspective regarding ozone precursor emissions in the upwind major metropolitan areas and in western Nevada County.

Figure 6: Summer Ozone Precursor Emissions – Western Nevada County, San Francisco Bay Area and Sacramento Non-Attainment Area. Source: CEPAM 1.04



The combination of minimal nighttime NOx scavenging and the gradual transport during the evening hours of ozone formed in upwind areas during the day frequently results in high nighttime ozone concentrations in western Nevada County that sometimes persist until well after sunrise (see Figure 7). Since the previous day's ozone is often still present after midnight, the area has occasionally have next-day exceedances of the 2008 federal ozone standard that begin at 1:00 AM. Figure 6 also illustrates the delayed effect of ozone transport from upwind areas. Auburn is approximately half-way between the Folsom-Natomas Street monitor in the Sacramento metropolitan area and Grass Valley.

Figure 7: Grass Valley Ozone Concentrations by Hour of Day, May-October, 2017.

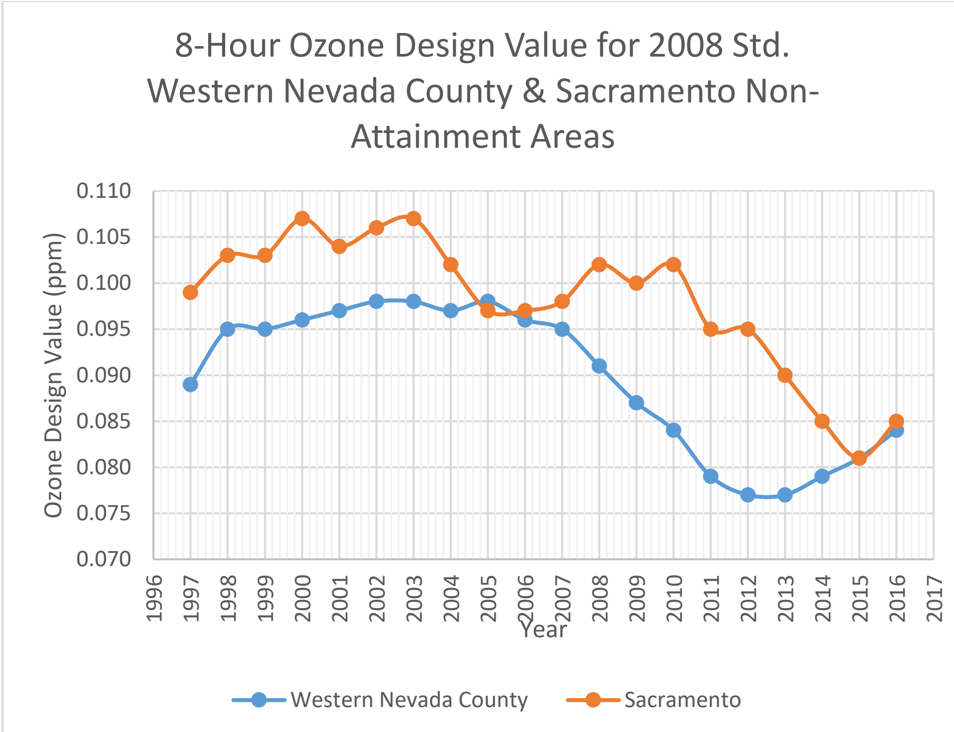


D. Ozone Trends

Western Nevada County's ozone concentrations have decreased considerably since the early 2000's. There has been a slight increase in the past few years, which is thought to be at least partially due to ozone precursor emissions from increased wildfire activity that has coincided with massive tree mortality due to California's bark beetle epidemic. Wildfires emit both VOCs and NOx in great quantities. Many of the highest ozone days have been accompanied by a light haze from numerous relatively small wildfires throughout the region – fires that are not large enough to yield clear determinations of exceptional events, but large enough to bump the concentrations up slightly.

Also, although the Sacramento area has been improving their local air quality and reducing O_3 and its precursor emissions, it has not yet attained the 2008 8-Hour Ozone NAAQS. Concurrently, the District has been improving its air quality to the extent of attaining the 1997 8-Hour Ozone NAAQS of 0.08ppm. Figure 8 compares the 8-Hour Ozone Design Value data for 1997-2016 for western Nevada County and the Sacramento Non-attainment Area.

Figure 8: Federal 8-Hour Ozone Design Values.



E. Biogenic Emission Inventory

The total Summer 2017 ROG emission inventory for all of Nevada County from anthropogenic sources (mobile, stationary and area-wide) is 5.4 tons per day. In contrast, biogenic emissions (natural emissions from vegetation) for the same area are estimated at 215.6 tons per day.
https://www.arb.ca.gov/app/emsinv/fcemssumcat/cepam_emssumcat_query_v5.php

Western Nevada County has very few emission inventory categories from which to reasonably reduce emissions. Stationary source emissions are relatively miniscule. The largest category of ROG emissions, as reflected in the emissions inventory for 2005 through 2020, is Recreational Boats. Consumer Products is the next largest category, and California already has an extremely aggressive statewide regulatory framework for minimizing emissions from consumer products.

F. Progress

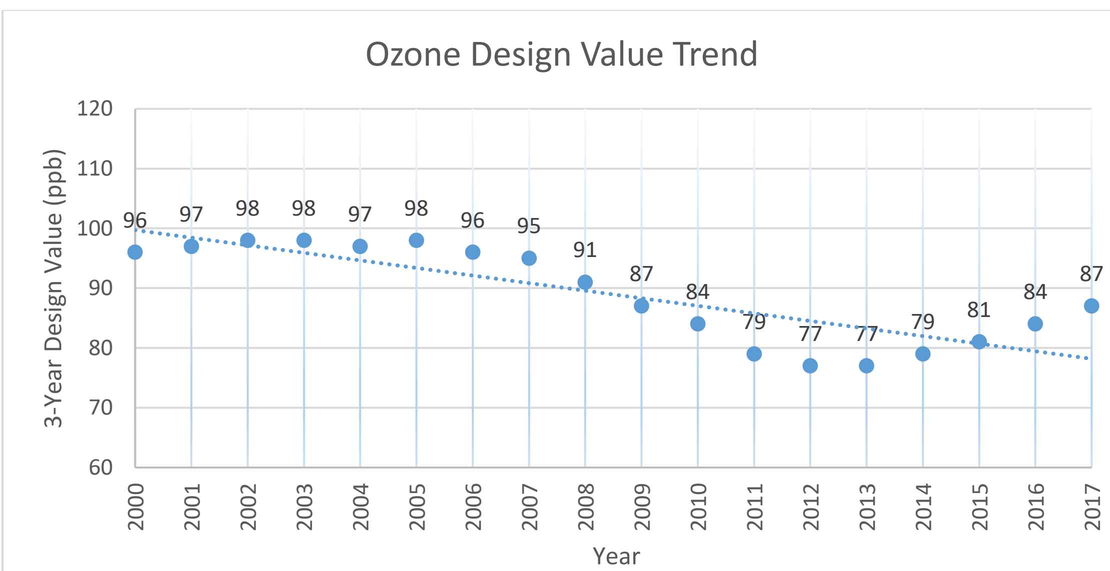
As reflected in the emission inventory[9], for the period 2007 through 2017, Western Nevada County reduced summer emissions of NOx by 54.8% and ROG by 34.2%. During the same period, the upwind Sacramento Non-attainment Area reduced summer

[9] CARB California Emissions Projection Analysis Model (CEPAM) emissions inventory, Version 1.05 at https://www.arb.ca.gov/app/emsinv/2016ozsip/2016ozsip/fcmasterdetail_sip2016.php.

emissions of NOx by 51.7% and ROG by 32.6%. For the period 2005 through 2017, Western Nevada County reduced summer emissions of total ozone precursors (NOx + ROG) by 49.6% while the Sacramento Non-attainment Area reduced summer emissions of total ozone precursors by 48.1%. Both areas have made substantial strides in recent years at reducing summer ozone precursor emissions, although Western Nevada County has achieved even greater reductions on a percentage basis.

Figure 9 illustrates the downward trend in Western Nevada County's ozone Design Value (3-year average of 4th highest annual value). The past few years have had slightly increasing Design Values, although this is considered an anomaly. The reason for this is not known, as anthropogenic emissions have continued to decline in both Western Nevada County and the upwind Sacramento region. One possible factor that is being considered is increased biogenic emissions from trees being stressed by an extended drought accompanied by a severe bark beetle epidemic. The drought ended in 2017 and beetle activity appeared to decrease by 2018, although many trees continued to struggle to survive the damage caused by the drought and the beetles. Preliminary data indicate numerous high ozone values during the summer of 2018, which are thought to be connected with precursor emissions from several enormous wildfires that burned through most of the summer (especially the Ferguson, Carr and Mendocino Complex fires) and will likely be the subject of Exceptional Event demonstrations for much of northern and central California. Nevada County's total population increased only marginally from 92,033 in 2000 to 98,639 in 2016 (1.9%)[10].

Figure 9: Western Nevada County Design Value Trend, 2000 – 2017.



[10] Total population for all of Nevada County, not just the Non-attainment area. California Department of Finance. Retrieved on 2017, May 31 at http://www.dof.ca.gov/Forecasting/Demographics/Estimates/

Minimal-impact development planning (such as the Sacramento area's Blueprint project), improving technologies and ongoing enforcement of existing rules and regulations will keep reducing O_3 precursor emissions for the foreseeable future. Furthermore, development and application of new lower emissions control technology at older, higher-emitting sources in the upwind Sacramento Region and the San Francisco Bay Area will continue to improve air quality in western Nevada County.

Although there are significant challenges ahead, CARB's modeling and analysis of current O_3 trends show the area will attain the 2008 8-Hour Ozone NAAQS by the end of 2020.

III. SERIOUS NON-ATTAINMENT RECLASSIFICATION REQUEST

Non-attainment areas are classified as marginal, moderate, serious, severe, or extreme, depending on the magnitude of the area's O 3 design value. In 2012, the western portion of Nevada County was classified "Marginal" non-attainment pursuant to the 2008, 8-hour ozone NAAQS Air Quality Designations[11]. In 2016, EPA published a Final Rule for "Determinations of Attainment by the Attainment Date, Extensions of the Attainment Date, and Reclassification of Several Areas for the 2008 Ozone NAAQS[12]". In the Rule, EPA determined that the Non-attainment Area failed to meet the 2008, 8-hour ozone NAAQS by the applicable attainment date of July 20, 2015.

Pursuant to CAA section 181(b)(2)(A), the Non-attainment Area was reclassified, by operation of law, as "Moderate" non-attainment effective June 3, 2016. This reclassification was based on the Western Nevada County's 8-hour O 3 design value of 0.079 ppm, calculated from O 3 concentrations collected at the Grass Valley – Litton Building air monitor during 2012-2014. This reclassification extended the attainment deadline for Western Nevada County to July 20, 2018, with attainment being demonstrated by the area attaining a 2015-2017 three-year design value of less than 75.4 ppb by December 31, 2017. As the 2015-2017 design value at the end of 2017 was reported to be 87 ppb, Western Nevada County failed to attain the 75 ppb standard and is eligible to be reclassified to "Serious" non-attainment.

Section 181(b)(3) of the CAA "Voluntary Reclassification" states: "The Administrator shall grant the request of any State to reclassify a non-attainment area in that State in accordance with table 1 of subsection (a) to a higher classification." The request for EPA to reclassify a non-attainment area to a higher classification will extend the time allowed for attainment. Reclassification is appropriate for areas that must rely on long-term strategies to achieve the emission reductions needed for attainment, even though more stringent requirements are imposed with each higher classification.

The District requests CARB formally submit a request to EPA asking for voluntary reclassification of the WNNA from "Moderate" to "Serious" non-attainment for the 2008, 8-hour Ozone NAAQS, and revise the attainment date to July 20, 2021, with an effective attainment date of December 31, 2020. This Ozone Attainment Plan is structured to satisfy the CAA's Serious area requirements.

IV. EMISSIONS INVENTORY BACKGROUND

Pursuant to CAA Section (§) 182(a)(1), a non-attainment area must develop an inventory of emissions in the area. An inventory is a comprehensive tabulation of air pollutants organized by emission source category. This Ozone Attainment Plan includes updated inventories of O_3 precursor emissions (VOC and NOx) for the 2011 base year (the year from which future-year inventories are projected)[11],[12] and the 2020 attainment year. Additionally, all inventory years in this Attainment Plan are derived from the 2011 base year inventory, except that 2012 is used as the baseline year for attainment modeling.

A. Emissions Inventory

Emissions inventories are one of the fundamental building blocks in the development of a State Implementation Plan (SIP or Plan). 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 document describes the emissions inventory included in the 8-hour Ozone Plan for the WNNA, which includes the western portion of Nevada County in the Northern Sierra Air Quality Management District. It also summarizes the revisions and improvements made to the inventory as part of this Plan.

The California Air Resources Board (CARB) and the Northern Sierra Air Quality Management District (NSAQMD; District) have developed a comprehensive, accurate, and current emissions inventory consistent with the requirements set forth in Section 182(a)(1) of the federal Clean Air Act. 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 by CARB.

B. 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 the primary input to air quality modeling used in attainment demonstrations; the emissions data used for developing control strategies; and

---

[11] CARB established 2012 as the emission inventory base year for 8-hour ozone planning purposes. See "Transmittal Letter to EPA" Richard Corey, Executive Officer, CARB, July 17, 2014. (https://www.arb.ca.gov/planning/sip/2012iv/ARB_2012O3SIP_transltr_to_EPA.pdf)

[12] 81 Federal Register 71997; October 19, 2016.

a means to track progress in meeting the emission reduction commitments.

The United States Environmental Protection Agency (U.S. EPA) regulations require that the emissions inventory contain emissions data for the two precursors to ozone formation: oxides of nitrogen (NOx) and volatile organic compounds (VOC). 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 U.S. EPA's list of VOCs.

C. Agency Responsibilities

CARB and District staff worked jointly to develop the emissions inventory for the WNNA. 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 consumer products 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.

D. Inventory Base Year for Modeling

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. U.S. EPA 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, U.S. EPA 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 South Coast Air Quality Management District typically aligns their base year inventory with the data collection period for their Multiple Air Toxics Exposure Study, which was last conducted in 2012, ARB selected 2012 as the base year to maintain consistency across the various plans being developed in the State.

E. Forecasted Inventories

In addition to a base year inventory, U.S. EPA 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.

F. 2011 Baseline Year Inventory for Reasonable Further Progress

The stationary emissions reflect actual emissions reported from industrial point sources. Stationary emissions also include stationary aggregate sources, which are categories such as gasoline dispensing facilities that are not inventoried individually but are estimated as a group and reported as an aggregated total. 2011 emissions for areawide, stationary aggregate sources and mobile are backcasted from a 2012 base year, relying on the same growth and control methodology as is used for future years. The 2012 inventory base year for modeling and the 2011 baseline year inventory for reasonable further progress are consistent with each other since they both use actual emissions for stationary sources and the same growth profiles.

G. 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 ozone concentrations tend to be highest during the summer months, the emission inventory used in the Plan is based on the summer season (May through October).

H. Geographical Scope

The inventories presented in this Plan include emissions for the WNNA, which consists of the western portion of Nevada County in the NSAQMD. Typically, emission inventories are developed at a county-level geographical resolution. The emissions for Nevada County were allocated to the Non-attainment Area using the approach described below.

Stationary Sources. Emissions from stationary sources were designated as being inside or outside the Non-attainment Area based on a GIS analysis of each facility's geographical coordinates (latitude and longitude) overlaid on a digitized map of the Non-attainment Area.

Areawide Sources. District staff conducted a thorough review of the areawide categories to determine those that actually occur in the Non-attainment Area. Human population was set as the default surrogate, with more specific spatial surrogates applied to remaining categories.

On-Road Mobile Sources. Emissions from on-road mobile sources were estimated at the county level using California's on-road motor vehicle model, EMFAC2014. The allocation to the Non-attainment Area planning inventory was accomplished using human population to distribute EMFAC2014 emissions.

Off-Road Mobile Sources. As with areawide sources, District staff conducted a review of the off-road categories to determine those that do not occur in the Non-attainment Area and should be zeroed out. Human population was set as the default surrogate and more specific spatial surrogates were applied to remaining categories.

Table 1 specifies the methods CARB used to allocate emissions to the WNNA.

Table 1: Method for the Spatial Allocation of Emissions to the Western Nevada County Ozone Non-attainment Area.

Source Category	Subcategory	Allocation Method
Stationary Point Sources	All	GIS Analysis
Area Source Component of Stationary Sources	Manufacturing & Industrial	Manufacturing sector employment
	Food & Agricultural Processing	Agricultural area
	Service & Commercial	Human population
	Other (Fuel Combustion)	Human population
	Landfills	Human population
	Degreasing	Human population
	Coatings & Related Process Solvents	Human population
	Printing	Human population
	Adhesives & Sealants	Human population
	Other (Cleaning & Surface Coatings)	Human population
	Petroleum Marketing	Human population
	Chemical	Human population
	Food & Agriculture	Farm types & area
	Mineral Processes	Land area
Areawide Sources	Consumer Products	Human population
	Architectural Coatings & Related Process Solvents	Human population
	Pesticides / Fertilizers	Agricultural area
	Asphalt Roofing & Paving	Land area
	Residential Fuel Combustion	Human population
	Farming Operations	Agricultural area

Table 1: Method for the Spatial Allocation of Emissions to the Western Nevada County Ozone Non-attainment Area.

	Fires	Human population
	Managed Burning & Disposal	Land area
	Cooking	Human population
On-Road Mobile Sources	All	Human population
Off-Road Mobile Sources	Aircraft	Aircraft activity
	Trains	Track length
	Recreational Boats	Boatable water area
	Off-Road Recreational Vehicles	Human population
	Off-Road Equipment	Human population
	Farm Equipment	Agricultural area
	Fuel Storage & Handling	Human population

I. 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 1.04. 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 Western Nevada County 8-hour Ozone Non-attainment Area Plan emissions inventory is presented in the sections below.

V. SUMMARY OF EMISSIONS INVENTORY METHODOLOGIES

The WNNA's emissions inventory is presented in Appendix A for the years 2011, 2012, 2014, 2017, 2020 and 2021.

A. Point Sources

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 U.S. EPA'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.

Table 2 lists the point source categories that occur in the ozone Non-attainment Area.

Table 2: Point Source Categories.

Source Category	Subcategory
Fuel Combustion	Electric Utilities
	Manufacturing and Industrial
	Food and Agricultural Processing
	Service and Commercial
	Other (Fuel Combustion)
Waste Disposal	Landfills
	Incinerators
Cleaning and Surface Coatings	Degreasing
	Coatings and Thinners
	Printing
	Adhesives and Sealants
	Other (Cleaning and Surface Coatings)
Petroleum Production and Marketing	Petroleum Marketing
Industrial Processes	Chemical
	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:

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

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 from the California Department of Conservation's Farmland Mapping and Monitoring Program (FMMP). Additional information on this category is available at: https://www.arb.ca.gov/ei/areasrc/arbfuelcombagric.htm

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 Regional Economic Models, Inc. (REMI) county economic forecasts. Additional information on this methodology is available at: https://www.arb.ca.gov/ei/areasrc/arbcleandegreas.htm

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 vehicles from CARB's EMFAC model. 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 most 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 REMI county economic forecasts. Additional information on these methodologies is available at: https://www.arb.ca.gov/ei/areasrc/arbcleancoatreproc.htm

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 REMI county economic forecasts. Additional information on this methodology is available at: https://www.arb.ca.gov/ei/areasrc/arbcleanadhseal.htm

Gasoline Dispensing Facilities
CARB staff developed an updated methodology in October 2015 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 2012 statewide gasoline sales data from the California Board of Equalization that were apportioned to the county level using fuel consumption estimates from CARB's on-road mobile sources model (EMFAC). Additional information on this category is available at: https://www.arb.ca.gov/ei/areasrc/arbpetprodmarkpm.htm

B. Areawide Sources

Areawide sources are categories such as consumer products, fireplaces, and agricultural burning (see Table 3) 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.

Table 3: Areawide Sources.

Source Category	**Subcategory**
Solvent Evaporation	Consumer Products
	Architectural Coatings and Related Solvents
	Pesticides and Fertilizers
	Asphalt Paving and Roofing
Miscellaneous Processes	Residential Fuel Combustion
	Farming Operations
	Fires
	Managed Burning and Disposal
	Cooking

A summary of the areawide methodologies is presented below:

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 California Department of Finance (DOF) population forecasts, 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.

Architectural Coatings
The architectural coatings category reflects emission estimates based on a comprehensive CARB survey for the 2004 calendar year. These emissions are grown based on DOF

population forecasts. Additional information about CARB's architectural coatings program is available at: https://www.arb.ca.gov/coatings/arch/arch.htm

Pesticides
DPR develops month-specific emission estimates for agricultural and structural pesticides. Each calendar year, DPR updates the inventory based on the Pesticide Use Reporting Program, 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), National Agricultural Statistics Service (NASS). Growth for structural pesticides is based on REMI projections of expenditures on structures.

Asphalt Paving/Roofing
Asphalt paving and roofing emissions were grown from 2005 estimates. 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 REMI county economic forecasts.

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 U.S. EPA's National Emission Inventory. Growth projections vary by fuel type, with wood based on DOF population forecasts, natural gas based on CEC forecasts, and other fuels based on Energy Information Administration (EIA) forecasts. Additional information on this methodology is available at:
https://www.arb.ca.gov/ei/areasrc/arbmiscprocresfuelcom.htm

Farming Operations
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. Based on an analysis of livestock population trends, no growth is assumed. Additional information on CARB's methodology is available at:
https://www.arb.ca.gov/ei/areasrc/arbmiscproclivestock.htm

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. Growth is based

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

Managed Burning and Disposal
CARB updated the emissions inventory to reflect burn data reported by District staff for 2008. Emissions are calculated using crop specific emission factors and fuel loadings. Temporal profiles reflect monthly burn activity. Growth for agricultural burning is based on CARB projections of USDA NASS harvested acreage. No growth is assumed for 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

Commercial Cooking
The 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 DOF population forecasts.

C. 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 4.

Table 4: Growth Surrogates for Point and Areawide Sources.

Source Category	Subcategory	Growth Surrogate
Electric Utilities	I. C. Reciprocating Engines	No growth
Manufacturing & Industrial	Natural Gas	CEC forecast
Food and Agricultural Processing	Ag Irrigation I. C. Engines	FMMP irrigated farmland acreage
Service and Commercial	Natural Gas	CEC forecast
	Other Fuels	No growth
Other (Fuel Combustion)	Diesel	CARB OFFROAD model combined with DOF population forecast
	Other Fuels	No growth
Waste Disposal	Landfills	DOF population forecast
	Incinerators	DOF population forecast
Degreasing	All	REMI county economic forecast
Coatings and Thinners	Auto Refinishing	Vehicles from CARB EMFAC model
	Others	REMI county economic forecast
Printing	All	REMI county economic forecast

Table 4: Growth Surrogates for Point and Areawide Sources.

Source Category	Subcategory	Growth Surrogate
Adhesives and Sealants	All	REMI county economic forecast
Other (Cleaning & Surface Coatings)	All	DOF population forecast combined with REMI county economic forecast
Petroleum Marketing	Natural Gas	CEC forecast
	Other Fuels	Fuel use from CARB EMFAC model
Chemical	All	REMI county economic forecast
Food and Agriculture	All	REMI county economic forecast
Mineral Processes	All	REMI forecast combined with Annual Energy Outlook
Consumer Products	Aerosol Coatings	No growth assumption
	Others	DOF population forecast
Architectural Coatings & Related Process Solvents	All	DOF population forecast
Pesticides & Fertilizers	Agricultural pesticides	CARB projection of USDA harvested acreage
	Structural pesticides	REMI forecast on spending on structures
Asphalt Paving & Roofing	All	REMI county economic forecast
Residential Wood Combustion	Wood	DOF population forecast
	Natural Gas	CEC forecast
	Other Residential Fuels	EIA forecast
Farming Operations	All	No growth assumption
Fires	All	DOF population forecast
Managed Burning & Disposal	Managed Farm Burning	CARB projection of USDA harvested acreage
	Other Managed Burning	No growth assumption
Cooking	All	DOF population forecast

D. 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 5.

Table 5: District and CARB Stationary Source Control Rules and Regulations Included in the Inventory

Agency	Rule/Reg No.	Rule Title	Source Categories Impacted
CARB	CARB_R003 and CARB_R003_A	Consumer Product Regulations & Amendments	Consumer products
CARB	CARB_R007	Aerosol Coating Regulation	Aerosol coatings
CARB	GDF_HOSREG	Gasoline Dispensing Facilities Hose Emission Regulation	Petroleum marketing
CARB	ORVR	Fueling emissions from ORVR vehicles	Petroleum marketing

E. 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.

F. 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. 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

G. 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, transportation refrigeration units, and others. The sections below summarize the updates made to specific off-road categories in the WNNA.

Locomotives
In 2014, CARB developed a revised inventory for line-haul locomotive activity in California. The new model is based primarily on activity data reported to CARB by the major rail lines for calendar year 2011. To estimate emissions, CARB used duty cycle, fuel consumption and activity data reported by the rail lines. Activity is forecasted for individual train types and is consistent with CARB's ocean-going vessel and truck growth rates. Fuel efficiency improvements are projected to follow Federal Railroad Association projections and turnover assumptions are consistent with U.S. EPA projections. Additional information is available at:
https://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles

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

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

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

Diesel Agricultural Equipment
The inventory for agricultural diesel equipment (such as tractors, harvesters, combines, sprayers and others) was revised based on a voluntary survey of farmers, custom operators, and first processors conducted in 2009. 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. 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

H. Mobile Source Forecasting

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

Table 6: Growth Surrogates for Mobile Sources.

Category	Growth Methodology
On-Road Sources	
All	Match total vehicle miles traveled (VMT) projections provided by Metropolitan Planning Organizations
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)

Table 6: Growth Surrogates for Mobile Sources.

Category	Growth Methodology
Off-Road Diesel-Fueled Equipment	
Commercial Harbor Craft	Growth rates provided by District, except for tugs and fishing vessels. Fishing fleet growth rates were adjusted to reflect a decline in fish landings. Assumed no growth for tugboats.
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)	International/premium train growth tied to OGV forecast; Domestic train growth tied truck growth
Transport Refrigeration Units	Projection of historical Truck/Trailer TRU sales from ACT Research, adjusted for recession.

VI. TRANSPORTATION CONFORMITY BUDGETS

Section 176(c) of CAA establishes transportation conformity requirements, which are intended to ensure transportation activities do not interfere with air quality progress. The CAA requires transportation plans, programs, and projects that obtain federal funds or approvals, be consistent with, or *conform to* the applicable SIP before being approved by a Metropolitan Planning Organization (MPO). Conformity to the SIP means that proposed transportation 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 reasonable further progress (RFP), attainment, or maintenance of the National Ambient Air Quality Standards (NAAQS). The portion of the total emissions inventory from on-road highway and transit vehicles which provides RFP and attainment of the NAAQS in these analyses becomes the "motor vehicle emissions budget". [13] Motor vehicle emissions budgets are the mechanism for ensuring that transportation planning activities conform to the SIP. Budgets are set for all RFP milestone and attainment year for each criteria pollutant or its precursors that the area does not attain. 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.

A. Requirements for Demonstrating Conformity

The Nevada County Transportation Commission (NCTC), the regional transportation planning agency for the County of Nevada, prepares a regional transportation plan (RTP) at least every five years and a short range funding program, or regional transportation improvement plan (RTIP), every two years. Content of both the RTP and RTIP are specified in federal transportation law found at Titles 23 and 49 of the federal code of regulations and applicable sections of state transportation planning law.

[13] 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 EPA in the August 15, 1997 Federal Register.

Before adopting the RTP/RTIP, NCTC prepares a regional emissions analysis using the proposed plan and program as specified in the federal conformity regulation and compares those emissions to the emission budgets in the SIP. NCTC may determine the RTP/RTIP conforms if the emissions from the proposed actions are less than the emissions budgets in the SIP. The conformity determination also signifies that transportation conformity requirements, such as interagency consultation and financial constraint, have been met.

Guidance on the precursors that must be considered in transportation conformity determinations is found in Section 93.102(b)(2)(i) of the Conformity Regulation, which requires motor vehicle emissions budgets for VOC and NOX as ozone precursors.

B. Conformity Budgets in the 2018 Ozone Attainment Plan

The 2018 Ozone Attainment Plan establishes transportation conformity emissions budgets for ozone precursors in the Western Nevada County ozone nonattainment area for the attainment year of 2020.

The emissions budgets presented below use EMFAC2014 with NCTC-modeled VMT and speed distributions. The VMT and speed distribution data are from the Nevada County Regional Transportation Plan: 2015-2035, adopted by NCTC in January 2018. Because these data represent the most recent data available, there are small differences between the budgets and planning inventory. These differences do not impact the attainment demonstration. EMFAC2014 was approved for use in SIPs and transportation conformity by U.S. EPA on December 14, 2015.

All the budgets in this plan have been constructed in consultation with NCTC and U.S. EPA, using emissions for a summer average day consistent with the ozone attainment and progress demonstrations, using the following method:

1) Calculate the on-road motor vehicle emissions totals for the appropriate ozone precursors (VOC and NOX) using EMFAC2014.
2) Sum each pollutant and round each total up to the nearest tenth (0.1) for VOC, NOX.

Table 7 below contains the emissions budgets for the Western Nevada County Ozone Nonattainment Area.

Table 7: Transportation Conformity Budgets for the 2008 8-hour Ozone standard in the Western Nevada County Ozone Nonattainment Area, tons per average summer day.

Western Nevada County Ozone Nonattainment Area	2020	
	VOC	NO_X
Baseline Emissions	0.75	1.61
Total	0.75	1.61
Conformity Budget*	0.8	1.7

*Budgets calculated with EMFAC2014 using NCTC 2018 RTP activity. Budgets are rounded up to the nearest tenth (0.1).

C. Banked Emission Reduction Credits

The NSAQMD has never had any banked Emission Reduction Credits. The District's New Source Review (NSR) rule (which was submitted to EPA 9/6/16, deemed a complete submission 9/28/16, and is pending EPA approval into the SIP) requires new and modified major stationary sources that increase emissions in amounts exceeding specified thresholds to provide emission reduction offsets to mitigate their emissions growth. Offsets represent either on-site emission reductions, ERC redemption from upwind areas or the use of banked emission reduction credits (ERCs), which are voluntary, surplus emission reductions previously achieved and registered with the District for future use as offsets.

VII. EMISSIONS STATEMENT RULE

Pursuant to CAA §182(a)(3)(B) 14 subsection (i), states must have an Emissions Statement program (i.e., rule) in place that requires stationary sources to annually report and certify accuracy of their NOx and VOC emissions. Subsection (ii) has waiver provisions for stationary sources emitting less than 25 tpy of NOx or VOC. District Rule 513 (Emission Statements and Recordkeeping), was revised in coordination with EPA to meet all applicable requirements and approved by the NSAQMD Board on 6/27/16. EPA approved the revised rule into the SIP 6/21/17 at 82 FR 28240.

[14] CAA §182(a)(3)(B) details Emissions Statement requirements for O_3 non-attainment areas classified as marginal and above.

VIII. NEW SOURCE REVIEW

The Clean Air Act §182(a)(2)(C) requires the District to address emissions from new sources and major modifications to existing sources. Pursuant to CAA §182(c)(10), the District is required to have an New Source Review (NSR) rule designed to address emissions from new and modified major stationary sources of NOx or VOC. District Rule 428 (New Source Review Requirements for New and Modified Major Sources in Federally Designated Non-attainment Areas) was last amended 6/27/16 following extensive communication with CARB and EPA. It was submitted to EPA 9/6/16 and deemed a complete submission 9/28/16. EPA has not taken further action on the Rule and it is currently pending EPA approval into the SIP.

The Rule was designed to accommodate changes in Classification, so the substance of the Rule is equally applicable to a Serious Non-attainment Area or a Moderate Non-attainment Area. However, the adopted Rule 428 references a 2015 version of the CFR. The first section reads,

> *1.1 Preconstruction Review Requirements* *The preconstruction review requirements of this rule apply to the proposed construction of any new major stationary source or any major modification located at an existing major stationary source, if the stationary source or modification is major for the regulated NSR pollutant for which the area it is to be located is designated non-attainment, as listed in 40 CFR 81.305, except as provided in 40 CFR 51.165(f)(1) through (15). All CFR references included in this rule refer to the CFR as of July 1, 2015.*

Since the Rule specifies "designated" rather than "classified," a change in classification may not trigger the need for a CFR date change, although CARB has informed the NSAQMD that the CFR publication date should be changed nonetheless. The NSAQMD plans to look further into the question and modify the Rule if necessary in the near future.

IX. SERIOUS NON-ATTAINMENT PLAN REQUIREMENTS

EPA's 2015 Implementation Rule for the 2008, 8-hour O_3 NAAQS requires additional planning and emission control demonstration necessary for serious non-attainment areas to comply with the CAA. These conditions go beyond the general requirements listed in Section IV of this plan and include the following:

Reasonably Available Control Measures (RACM): CAA §172(c) requires the District to verify that all RACM including stationary, transportation, and mobile) are being implemented as expeditiously as practicable.

Reasonable Further Progress (RFP): CAA §182(b)(1) requires the District to provide RFP to show steady progress in emission reduction between the baseline planning (2008), base year (2012), and attainment year (2020).

Attainment Demonstration: CAA §182(c)(2)(A) requires the District to develop photochemical air quality simulation modeling that demonstrates attainment of 2008 8-hour Ozone NAAQS as expeditiously as practicable.

Contingency Measures: CAA §179(c)(9) requires the District to implement contingency measures in the event of failure to achieve Reasonable Further Progress (RFP) milestones or to attain 2008 8-hour Ozone NAAQS by the attainment deadline.

X. REASONABLE AVAILABLE CONTROL MEASURES

CAA §172(c)(1) and (c)(2) requires the District to demonstrate that it has adopted all control measures necessary to attain the 2008 8-hour Ozone NAAQS as expeditiously as practicable. RACM applies to stationary source control measures, transportation control measures, and mobile source control measures.

EPA has interpreted RACM to be those emission control measures that are technologically and economically feasible and when considered in aggregate, would advance the attainment date by at least one year. Emission reductions from RACM must be sufficient in reducing the emission inventory projected for 2020 (or earlier) to that currently projected for the attainment year 2021.

A. RACM for Stationary Sources

The District's stationary source NOx and VOC prohibitory rules have been addressed in the District's Reasonable Available Control Technology (RACT) SIP[15]. RACT is the minimum required level of RACM and applies to specific categories of stationary sources to which EPA-issued Control Technique Guidelines (CTGs) apply. The RACT SIP implements all applicable CTGs published by EPA through 2016 (see Table 8).

Table 8: CTG Summary Table Indicating NSAQMD's RACT Actions and Negative Declarations for the 2008 NAAQS.

CTG Titles and References	Determinations and Actions
1. Design Criteria for Stage I Vapor Control Systems - Gasoline Service Stations, November 1975. [EPA never assigned a document number to this CTG.]	These criteria are incorporated into State regulations for Stage 1 vapor recovery. The District revised Rule 214 (approved by EPA at 78 FR 897, 1/7/13) to specify associated RACT requirements.
2. Control of Volatile Organic Emissions from Existing Stationary Sources, Volume I: Control Methods for Surface Coating Operations, EPA-450/2-76-028, November 1976. [This document is a compilation of control techniques.]	This does not define RACT for a specific source category, so it was not implemented as RACT. Individual District operating permits specify control techniques for sources in this category.
3. Control of Volatile Organic Emissions from Existing Stationary Sources, Volume II: Surface Coating of Cans, Coils, Paper, Fabrics, Automobiles, and Light-Duty Trucks, EPA-450/2-77-008, May 1977.	There are no existing or anticipated sources in these categories in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/13/15 at 80 FR 19544. The District continues to have no sources subject to this CTG.

[15] See Appendix E.

	Negative Declaration for 2008 NAAQS
4. Control of Volatile Organic Emissions from Solvent Metal Cleaning, EPA-450/2-77-022, November 1977.	The only source type in the Non-attainment Area that is covered by this CTG is cold cleaners. These are exempt from RACT in the Non-attainment Area because it is rural (pop. <200,000), pursuant to the EPA memo, "Clarification of Degreasing Regulation Requirements" (September 7, 1978).[16] A negative declaration was approved by EPA for the 1997 NAAQS 4/13/15 at 80 FR 19544. *Negative Declaration for 2008 NAAQS*
5. Control of Refinery Vacuum Producing Systems, Wastewater Separators, and Process Unit Turnarounds, EPA-450/2-77-025, October 1977.	There are no existing or anticipated sources in this category in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/13/15 at 80 FR 19544. *Negative Declaration for 2008 NAAQS*
6. Control of Hydrocarbons from Tank Truck Gasoline Loading Terminals, EPA-450/2-77-026, December 1977.	There are no existing or anticipated sources in this category in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/13/15 at 80 FR 19544. *Negative Declaration for 2008 NAAQS*
7. Control of Volatile Organic Emissions from Existing Stationary Sources, Volume III: Surface Coating of Metal Furniture, EPA-450/2-77-032, December 1977.	There are no existing or anticipated sources in this category that exceed de minimis levels (actual emissions of 15 lbs./day) in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/13/15 at 80 FR 19544. *Negative Declaration for 2008 NAAQS*
8. Control of Volatile Organic Emissions from Existing Stationary Sources, Volume IV: Surface Coating for Insulation of Magnet Wire, EPA-450/2-77-033, December 1977.	There are no existing or anticipated sources in this category in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/13/15 at 80 FR 19544. *Negative Declaration for 2008 NAAQS*

[16] The September 7, 1978 memo is available at https://www3.epa.gov/ttn/naaqs/aqmguide/collection/Doc_0027_VOC150907781.pdf

9. Control of Volatile Organic Emissions from Existing Stationary Sources, Volume V: Surface Coating of Large Appliances, EPA-450/2-77-034, December 1977.	There are no existing or anticipated sources in this category in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/13/15 at 80 FR 19544. *Negative Declaration for 2008 NAAQS*
10. Control of Volatile Organic Emissions from Bulk Gasoline Plants, EPA-450/2-77-035, December 1977.	There are no existing or anticipated sources in this category that exceed de minimis levels (4,000 gallons per day throughput on a 30-day rolling average)[17] in the Non-attainment Area. This CTG was addressed in the NSAQMD's 2/7/08 RACT submittal by stating that NSAQMD's Rules 219 and 220 collectively met RACT requirements, but those rules are not in the SIP and EPA has not taken action on that portion of the 2/7/08 submittal. However, since there are no sources in the area with throughput great enough to trigger CTG applicability anyway, the CTG is being addressed here on that basis as a negative declaration. *Negative Declaration for 2008 NAAQS*
11. Control of Volatile Organic Emissions from Storage of Petroleum Liquids in Fixed Roof Tanks, EPA-450/2-77-036, December 1977.	There are no existing or anticipated sources in this category in the Non-attainment Area, so a negative declaration is included in this submittal. *Negative Declaration for 2008 NAAQS*
12. Control of Volatile Organic Compounds from Use of Cutback Asphalt, EPA-450/2-77-037, December 1977.	The District adopted Rule 227 (approved by EPA at 74 FR 56120, 10/30/09) to implement RACT for this source category.
13. Control Techniques for Volatile Organic Emissions from Stationary Sources, EPA-450/2-78-022, May 1978.	This does not define RACT for a specific source category, so it was not implemented as RACT. Individual District operating permits specify control techniques for sources in this category.
14. Control of Volatile Organic Emissions from Existing Stationary Sources, Volume	The District adopted Rule 228 (approved by EPA at 77 FR 47536,

[17] See Model VOC rules for RACT, June 1992, page 122, available at https://archive.epa.gov/ttn/ozone/web/pdf/voc_modelrules.pdf

VI: Surface Coating of Miscellaneous Metal Parts and Products, EPA-450/2-78-015, June 1978.	10/9/12) to implement RACT for this source category.
15. Control of Volatile Organic Emissions from Existing Stationary Sources, Volume VII: Factory Surface Coating of Flat Wood Paneling, EPA-450/2-78-032, June 1978.	There are no existing or anticipated sources in this category in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/13/15 at 80 FR 19544. The District continues to have no sources subject to this CTG. *Negative Declaration for 2008 NAAQS*
16. Control of Volatile Organic Compound Leaks from Petroleum Refinery Equipment, EPA-450/2-78-036, June 1978.	There are no existing or anticipated sources in this category in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/13/15 at 80 FR 19544. *Negative Declaration for 2008 NAAQS*
17. Control of Volatile Organic Emissions from Manufacture of Synthesized Pharmaceutical Products, 450/2-78-029, December 1978.	There are no existing or anticipated sources in this category in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/13/15 at 80 FR 19544. *Negative Declaration for 2008 NAAQS*
18. Control of Volatile Organic Emissions from Manufacture of Pneumatic Rubber Tires, EPA-450/2-78-030, December 1978.	There are no existing or anticipated sources in this category in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/13/15 at 80 FR 19544. *Negative Declaration for 2008 NAAQS*
19. Control of Volatile Organic Emissions from Existing Stationary Sources, Volume VIII: Graphic Arts - Rotogravure and Flexography, EPA-450/2-78-033, December 1978.	There are no existing or anticipated sources in these categories that exceed 100 tpy[18] de minimis levels in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/13/15 at 80 FR 19544. The District continues to have no sources subject to this CTG. *Negative Declaration for 2008 NAAQS*
20. Control of Volatile Organic Emissions from Petroleum Liquid Storage in External	There are no existing or anticipated sources in this category in the Non-

[18] See Table 2 in EPA's VOC Blue Book, May 25, 1988, available at https://archive.epa.gov/ttn/ozone/web/pdf/voc_bluebook.pdf

Floating Roof Tanks, EPA-450/2-78-047, December 1978.	attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/13/15 at 80 FR 19544. *Negative Declaration for 2008 NAAQS*
21. Control of Volatile Organic Emissions from Perchloroethylene Dry Cleaning Systems, EPA-450/2-78-050, December 1978.	No longer a required RACT analysis category, since PERC has been exempted as a VOC.
22. Control of Volatile Organic Compound Leaks from Gasoline Tank Trucks and Vapor Collection Systems, EPA-450/2-78-051, December 1978.	The District revised Rule 214 (approved by EPA at 78 FR 897, 3/8/13) to implement RACT for this source category. Approved by EPA at 77 FR 47536, 10/9/12.
23. Fugitive Emission Sources of Organic Compounds – Additional Information on Emissions, Emission Reductions, and Costs, EPA-450/3-82-010, April 1982.	This does not define RACT for a specific source category, so it was not implemented as RACT. It is included on EPA's published CTG list, so it is being included in this list for public information, even though it is not technically a real CTG.
24. Control of Volatile Organic Compound Emissions from Large Petroleum Dry Cleaners, EPA-450/3-82-009, September 1982.	There are no existing or anticipated sources in this category that exceed de minimis levels (32,500 gallons/year) in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/13/15 at 80 FR 19544. *Negative Declaration for 2008 NAAQS*
25. Control of Volatile Organic Compound Emissions from Manufacture of High-Density Polyethylene, Polypropylene, and Polystyrene Resins, EPA-450/3-83-008, November 1983.	There are no existing or anticipated sources in these categories in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/13/15 at 80 FR 19544. *Negative Declaration for 2008 NAAQS*
26. Control of Volatile Organic Compound Equipment Leaks from Natural Gas/Gasoline Processing Plants, EPA-450/2-83-007, December 1983.	There are no existing or anticipated sources in these categories in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/13/15 at 80 FR 19544. *Negative Declaration for 2008 NAAQS*
27. Control of Volatile Organic Compound Fugitive Emissions from Synthetic Organic	There are no existing or anticipated sources in these categories in the Non-attainment Area. A negative

Chemical Polymer and Resin Manufacturing Equipment, EPA-450/3-83-006, March 1984.	declaration was approved by EPA for the 1997 NAAQS 4/13/15 at 80 FR 19544. *Negative Declaration for 2008 NAAQS*
28. Control of Volatile Organic Compound Emissions from Air Oxidation Processes in Synthetic Organic Chemical Manufacturing Industry, EPA-450/3-84-015, December 1984.	There are no existing or anticipated sources in this category in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/13/15 at 80 FR 19544. *Negative Declaration for 2008 NAAQS*
29. Control of Volatile Organic Compound Emissions from Reactor Processes and Distillation Operations in Synthetic Organic Chemical Manufacturing Industry, EPA 450/4-91-031, August 1993.	There are no existing or anticipated sources in this category in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/13/15 at 80 FR 19544. *Negative Declaration for 2008 NAAQS*
30. Control of Volatile Organic Compound Emissions from Wood Furniture Manufacturing Operations, EPA-453/R-96-007, April 1996.	There are no existing or anticipated sources in this category that exceed de minimis levels (potential to emit 25 tons per year of VOCs) in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/13/15 at 80 FR 19544. *Negative Declaration for 2008 NAAQS*
31. Control Techniques Guidelines for Shipbuilding and Ship Repair Operations (Surface Coating), EPA 453/R-94-032, August 1996.	There are no existing or anticipated sources in this category in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/13/15 at 80 FR 19544. *Negative Declaration for 2008 NAAQS*
32. Aerospace (CTG & MACT), EPA-453/R-97-004, December 1997.	There are no existing or anticipated sources in this category in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/13/15 at 80 FR 19544. *Negative Declaration for 2008 NAAQS*
33. Control Techniques Guidelines for Industrial Cleaning Solvents, EPA-453/R-06-001, September 2006.	There are no existing or anticipated sources in this category that exceed 15

	lbs./day actual emissions[19] de minimis levels in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/18/12 at 77 FR 23130. *Negative Declaration for 2008 NAAQS*
34. Control Techniques Guidelines for Offset Lithographic Printing and Letterpress Printing, EPA-453/R-06-002, September 2006.	There are no existing or anticipated sources in this category that exceed de minimis levels (actual emissions of 15 lbs./day or 3 tons per 12-month period) in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/18/12 at 77 FR 23130. *Negative Declaration for 2008 NAAQS*
35. Control Techniques Guidelines for Flexible Package Printing, EPA-453/R-06-003, September 2006.	There are no existing or anticipated sources in this category that exceed de minimis levels (actual emissions of 15 lbs./day or 3 tons per 12-month period) in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/18/12 at 77 FR 23130. *Negative Declaration for 2008 NAAQS*
36. Control Techniques Guidelines for Flat Wood Paneling Coatings, EPA-453/R-06-004, September 2006.	There are no existing or anticipated sources in this category in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/18/12 at 77 FR 23130. *Negative Declaration for 2008 NAAQS*
37. Control Techniques Guidelines for Paper, Film, and Foil Coatings, EPA 453/R-07-003, September 2007.	There are no existing or anticipated sources in this category in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/18/12 at 77 FR 23130. *Negative Declaration for 2008 NAAQS*
38. Control Techniques Guidelines for Large Appliance Coatings, EPA 453/R-07-004, September 2007.	There are no existing or anticipated sources in this category in the Non-attainment Area. A negative declaration was approved by EPA for

[19] See page 5 of the CTG, available at https://www3.epa.gov/airquality/ctg_act/200609_voc_epa453_r-06-001_ind_cleaning_solvents.pdf

	the 1997 NAAQS 4/18/12 at 77 FR 23130. *Negative Declaration for 2008 NAAQS*
39. Control Techniques Guidelines for Metal Furniture Coatings, EPA 453/R-07-005, September 2007.	There are no existing or anticipated sources in this category that exceed 15 lb/day[20] actual emissions de minimis levels in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/18/12 at 77 FR 23130. *Negative Declaration for 2008 NAAQS*
40. Control Techniques Guidelines for Miscellaneous Metal and Plastic Parts Coatings, EPA 453/R-08-003, September 2008.	The District adopted Rule 228 (approved by EPA at 77 FR 47536, 10/9/2012) to implement RACT for this source category. The District also adopted a Negative declaration for plastic parts coatings and heavier duty vehicle coatings on 2/22/10 (received by EPA 7/20/10), which EPA has not yet taken action on, for portions of the CTG that don't apply in the Non-attainment Area. The District is also adopting a negative declaration for pleasure craft coatings. In summary, negative declarations are claimed for sources covered under Tables 3-6 of the CTG.
41. Control Techniques Guidelines for Fiberglass Boat Manufacturing Materials, EPA 453/R-08-004, September 2008.	There are no existing or anticipated sources in this category that exceed de minimis levels (actual emissions of 15 lbs./day or 2.7 tons per 12-month period) in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/18/12 at 77 FR 23130. *Negative Declaration for 2008 NAAQS*
42. Control Techniques Guidelines for Miscellaneous Industrial Adhesives, EPA 453/R-08-005, September 2008.	There are no existing or anticipated sources in this category that exceed de minimis levels (actual emissions of 15 lbs./day or 3 tons per 12-month period) in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/18/12 at 77 FR 23130.

[20] See page 3 of the CTG, available at https://www3.epa.gov/airquality/ctg_act/200709_voc_epa453_r-07-005_metal_furniture_coating.pdf

	Negative Declaration for 2008 NAAQS
43. Control Techniques Guidelines for Automobile and Light-Duty Truck Assembly Coatings, EPA 453/R-08-006 (and Protocol for Determining the Daily Volatile Organic Compound Emission Rate of Automobile and Light-Duty Truck Primer-Surfacer and Topcoat Operations, EPA 453/R-08-002), September 2008.	There are no existing or anticipated sources in this category that exceed de minimis levels (actual emissions of 15 lbs./day) in the Non-attainment Area. A negative declaration was approved by EPA for the 1997 NAAQS 4/18/12 at 77 FR 23130. *Negative Declaration for 2008 NAAQS*
44. Control Techniques Guidelines for the Oil and Natural Gas Industry, EPA 453/B-16-001, October 2016.	There are no existing or anticipated sources in this category in the Non-attainment Area (see Section 2.0 of this document). *Negative Declaration for 2008 NAAQS*
Major stationary sources of VOC	There are no existing or anticipated major sources of VOC in the Non-attainment Area. *Negative Declaration for 2008 NAAQS*
Major stationary sources of NO_x	There are no existing or anticipated major sources of NO_x in the Non-attainment Area. *Negative Declaration for 2008 NAAQS*

B. RACM for Mobile Sources

Many California regions face challenges in reducing mobile source emissions due to their large populations. Given the severity of these air quality challenges, CARB has implemented one of the most stringent mobile source emissions control programs in the nation.

CARB maintains regulatory authority over most mobile sources in California, which include: light, medium, and heavy-duty on-road vehicles, motorcycles, off-road equipment, recreational boats, cargo handling equipment, commercial harbor craft, and the fuels powering mobile equipment. Measures usually take a comprehensive approach to reduce emissions by continually establishing stringent engine standards, deadlines for procurement, fuel specifications, and incentive programs that encourage early adoption of lower-emitting equipment. Many California air districts rely on mobile source emission reduction measures to achieve timely attainment of state and federal air quality standards.

Nevada County has had a Basic Smog Check (Inspection & Maintenance) program in place since 1998, and was included in the 2005 program upgrades. California law (California Health and Safety Code §44003) provides that in areas where this program is implemented, it applies in Urbanized Areas (defined by State Law as having a population of 50,000 or more). Since there are no "Urbanized Areas" in Nevada County, Enhanced Smog Check is not an available option.

There are numerous additional RACM-type emission reduction measures already incorporated into local policies and planning procedures. Nevada County has already begun installing roundabouts in lieu of stop signs where appropriate. The Air District regularly encourages pedestrian access to goods and services as part of its planning document comments. Several park-and-ride facilities have been installed over the past 2 decades. Through several state-funded grant programs, mobile sources are achieving emission reductions.

Analysis of CARB's mobile source regulations & emission reductions programs is included in Appendix C. CARB's technologically and economically feasible RACM for mobile sources is also included in Appendix D. Analysis of Appendix D concludes California's current mobile source control program has no additional reasonably available measures (and consequently, no additional emission reductions) that could advance the District's attainment of the 2008, 8-hour ozone NAAQS by one year.

C. RACM for Areawide Sources

Areawide sources are largely regulated by existing programs and policies. An aggressive wood stove replacement program was implemented in 2018 utilizing California Cap and Trade funds. High-speed internet access is flourishing in the area. Nearly all architectural and automotive coatings sold in the area are designed for sale anywhere in California, meeting even the strictest standards. Curbside green waste pickup is available throughout the Non-attainment Area. There are Countywide regulations on fireplaces. Open burning is restricted in many ways (most notably a Nevada County ordinance prohibits burning piles that are primarily leaves and pine needles).

Consumer Products

Consumer products are defined as chemically formulated products used by household and institutional consumers. For more than 25 years, CARB has taken actions pertaining to the regulation of consumer products. Three regulations have set VOC limits for 129 consumer product categories. These regulations, referred to as the Consumer Product Program, have been amended frequently, and progressively stringent VOC limits and reactivity limits have been established. These are: Regulation for Reducing VOC Emissions from Antiperspirants and Deodorants; Regulation for Reducing Emissions from Consumer Products; and Regulation for Reducing the Ozone Formed from Aerosol Coating Product Emissions, and the Tables of Maximum Incremental Reactivity Values. Additionally, a voluntary regulation, the Alternative Control Plan has been adopted to provide compliance flexibility to companies. The program's most recent rulemaking occurred in 2013.

U.S. EPA also regulates consumer products. U.S. EPA's consumer products regulation was promulgated in 1998, however, federal consumer products VOC limits have not been revised since their adoption. U.S. EPA also promulgated reactivity limits for aerosol coatings. As with the general consumer products, California's requirements for aerosol coatings are more stringent than the U.S. EPA's requirements. Other jurisdictions, such as the Ozone Transport Commission states, have established VOC limits for consumer products which are modeled after the California program. However, the VOC limits typically lag those applicable in California.

In summary, California's Consumer Products Program, with the most stringent VOC requirements applicable to consumer products, meets RACM.

D. RACM Conclusion

Biogenic ROG emissions in the Non-attainment Area dwarf anthropogenic emissions by approximately 40 to 1 (see Appendix G). NOx and ROG emissions from wildfires are purely dependent on unforeseeable wildfire fire activity both locally and upwind. Existing guidance calls for ignoring the influence of biogenic and other natural emissions, and exclusively focusing on anthropogenic emissions for analyzing the effects of RACM.

Discarding biogenic and other natural emissions from the inventory for the purpose of evaluating RACM, additional reductions of 0.06 tpd of ROG and 0.23 tpd of NOx (0.29 tpd total, which equals 106 tons per year) would be necessary in 2020 to advance the District's attainment year from 2021 to 2020, as presented in Table 9.

Table 9: Projected Daily Emissions 2020 versus 2021 (Summer).

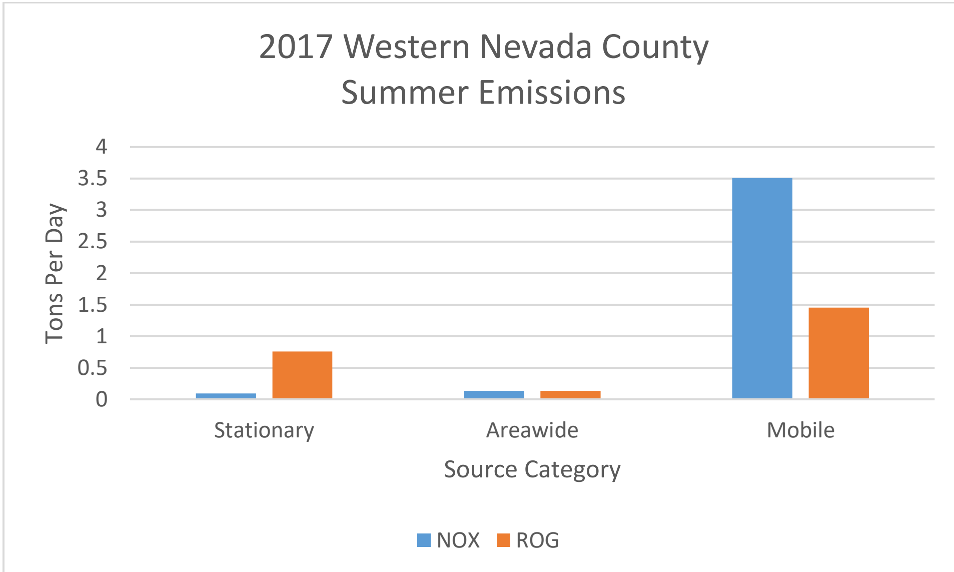
ROG Emissions (tons per day)			NOx Emissions (tons per day)		
2020	**2021**	**Difference**	**2020**	**2021**	**Difference**
4.2552	4.1985	0.0567	3.1181	2.8916	0.2265

Source: CARB CEPAM emissions inventory, Version 1.05.

An annual reduction in O_3 precursors of more than 100 tons is theoretically needed to advance the District's attainment date by at least one year. All applicable RACT measures have already been implemented, and the District is unable to identify additional reasonably available measures for reducing emissions to this extent.

In evaluating RACM adequacy, it is helpful to have a perspective of the emissions inventory. Mobile sources account for the bulk of the area's anthropogenic emissions. As apparent in the 2017 summer inventory, total mobile source precursor emissions dwarf areawide source emissions 18.2 to 1 and stationary source emissions 5.8 to 1. The difference is even more pronounced for NOx alone, with mobile source emissions being 38 times greater than stationary source emissions and 25.8 times greater than areawide source emissions. As discussed elsewhere in this document, mobile sources are already being regulated to the maximum extent feasible.

Figure 10: Emissions Inventory Overview.



Ozone precursor emissions (NOx plus ROG) from stationary sources only account for 16% of the area's total anthropogenic emissions (and only 2.5% of the area's anthropogenic NOx emissions).

In conclusion, the District has been unable to find a combination of potential additional control measures that are reasonably available for advancing the attainment year, and therefore no further control measures are being proposed for this Attainment Plan.

XI. REASONABLE FURTHER PROGRESS (RFP)

Clean Air Act sections 172(c)(2) and 182(b)(1) require attainment plans to provide for reasonable further progress (RFP). RFP is defined in Clean Air Act section 171(1) as "such annual incremental reductions in emissions of the relevant air pollutant as are required…for the purpose of ensuring attainment of the applicable NAAQS by the applicable date." This requirement to demonstrate steady progress in emission reductions between the baseline year and attainment date ensures that areas will not delay implementation of control programs until immediately before the attainment deadline.

There are two separate requirements for non-attainment areas depending upon their classification. The first is a one-time requirement for a 15 percent reduction in ROG emissions over the first 6 years of the planning period for non-attainment areas classified as moderate or above (section 182(b)(1)). The second is an additional 3 percent per year reduction, averaged over each consecutive 3-year period, of ozone precursor emissions until attainment for ozone non-attainment areas classified as serious or higher (section 182(c)(2)(B)).

<u>Fifteen Percent ROG-only Rate of Progress Requirement</u>
The March 2015 U.S. EPA implementation rule (Rule) for the 75 ppb 8-hour ozone standard interprets the Clean Air Act RFP requirements, establishing requirements for RFP that depend on the area's classification and whether the area has an approved 15 percent ROG-only reduction plan for a previous ozone standard that covers all of the 75 ppb 8-hour ozone non-attainment area (80 FR 12264).

Northern Sierra AQMD has never submitted, nor had approved by U.S. EPA, a 15 percent ROG-only rate of progress plan for the WNNA. As a result, the 15 percent ROG-only requirement still needs to be met for Western Nevada County.

<u>Reasonable Further Progress Requirements</u>
The WNNA must demonstrate a reduction in ROG of "at least 15 percent from baseline emissions" (section 182(b)(1)(A)(i)) for the first 6 years of the attainment planning period. As a serious non-attainment area, Western Nevada County is also subject to RFP under section 182(c)(2)(B) and must show "an additional emissions reduction of 3 percent per year from the end of the first 6 years" (80 FR 12264), averaged over each consecutive 3-year period until the attainment year.

As detailed in the Rule, emission reductions must be achieved through existing programs. The Western Nevada County RFP demonstration is achieved by forecasted emission reductions from existing control regulations as shown in the planning inventory. As required, ROG emission reductions alone are used to meet the 15 percent reduction target for the initial six year period, but both ROG and NOx emission reductions are needed to meet the remaining RFP target. The NOx substitution is used on a percentage basis to cover any percentage shortfall in ROG reduction. In 2018, courts determined that the appropriate baseline year for RFP for the 75 ppb 8 hour ozone standard is 2011; therefore, the Western Nevada County RFP demonstration uses a 2011 baseline year.

The table below was developed in accordance with all applicable and currently-available U.S. EPA-published guidance and demonstrates that Western Nevada County meets the RFP targets in the milestone years of 2017 and 2020.

Table 10: Western Nevada County 75 ppb 8-hour Ozone Reasonable Further Progress (summer planning inventory, tons per day)

Year	2011	2017	2020
Baseline ROG	5.5	4.5	4.3
Required % change since 2011 (ROG or NOx)		15%	24%
Target ROG level		4.7	4.2
Apparent Shortfall (-)/ Surplus (+) in ROG		0.2	-0.1
Apparent Shortfall (-)/ Surplus (+) in ROG, %		3.2%	-1.4%
ROG shortfall previously provided by NOx substitution, %		0.0%	0.0%
Actual ROG Shortfall (-)/ Surplus (+), %		3.2%	-1.4%
Year	**2011**	**2017**	**2020**
Baseline NOx	5.7	3.7	3.1
Change in NOx since 2011		2.0	2.6
Change in NOx since 2011, %		34.3%	45.2%
NOx reductions since 2011 already used for ROG substitution through last milestone year, %		0.0%	0.0%
NOx reductions since 2011 available for ROG substitution in this milestone year, %		34.3%	45.2%
NOx reductions since 2011 used for ROG substitution in this milestone year, %		0.0%	1.4%
NOx reductions since 2011 surplus after meeting ROG substitution needs in this milestone year, %		34.3%	43.8%
Total shortfall (-) for RFP, if any		0.0%	0.0%
RFP Met?		YES	YES

XII. ATTAINMENT DEMONSTRATION

Photochemical modeling plays a crucial role in the SIP process to demonstrate attainment of air quality standards based on estimated future emissions and for the development of emissions targets necessary for attainment. The WNNA (WNNA) is designated as a moderate ozone Non-attainment Area for the 2008 0.075 ppm (or 75 ppb) 8-hour ozone standard and is required to demonstrate attainment of this standard by 2017. However, since the WNNA exceeded the 75 ppb ozone standard in 2017, the region will almost certainly be reclassified as serious non-attainment, which will extend the attainment deadline until 2020. As a result, the future year for this modeling attainment demonstration is 2020.

In the WNNA, 8-hour ozone (O_3) design values (DVs) in recent years have shown an upward trend, increasing from 77 ppb in 2013 to 81 ppb in 2015, 84 ppb in 2016, and 87 ppb in 2017[21]. Preliminary data for 2018 suggest that the increasing trend may be leveling off.

The findings of the WNNA's model attainment demonstration are summarized below. Additional information and a detailed description of the procedures employed in this modeling are available in the Modeling Attainment Demonstration and Modeling Protocol Appendices. The current modeling platform draws on the products of large-scale, scientific studies in the region, collaboration among technical staff of State, Local, and Federal regulatory agencies, as well as from participation in technical and policy groups within the region (see Modeling Protocol Appendix H for further details). In this modeling work, the Weather Research and Forecasting (WRF) numerical model version 3.6 was utilized to generate meteorological fields, while the Community Multiscale Air Quality (CMAQ) Model version 5.0.2 was used for modeling ozone in the WNNA. Other relevant information, including the modeling domain definition, chemical mechanism, initial and boundary conditions, and emissions preparation can be found in the Modeling Protocol and Modeling Emissions Inventory Appendices.

Based on U.S. EPA modeling guidance[22], modeling was used in a relative sense to project observed DVs to the future. The year 2012 was chosen as the baseline modeling year based on an analysis of how conducive the meteorology was towards ozone formation, as well as the availability of the most detailed emissions inventory. Consistent with WNNA's mandated attainment deadlines, the future year 2020 was modeled.

DVs are the three-year average of the annual 4th highest 8-hour O_3 levels observed at each monitor, and are used to determine compliance with the 75 ppb standard. In the attainment demonstration, the U.S. EPA recommends[1] using an average of three DVs, which straddle the baseline modeling year, to account for the year-to-year variability in

[21] Data for 2017 are preliminary and subject to further review available from https://www.arb.ca.gov/aqmis2/ozone_annual.php

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

meteorology. This average DV, called a baseline DV, serves as the anchor point for estimating future year projected DVs. In order to better account for the recent shift in WNNA's DV trend and to assess its impact on the timeframe for attainment of the 75 ppb standard, a more representative baseline DV that was based on DVs from 2013, 2014, and 2015 (shown in 1st column of Table 12) was utilized to calculate future DVs in this attainment demonstration.

In the attainment demonstration, modeling is utilized in a relative sense, which required three simulations to be conducted: 1) base year simulation for 2012, which was used to verify that the model reasonably reproduced the observed air quality; 2) reference year simulation for 2012, which was the same as the base year simulation, but excluded exceptional event emissions such as wildfires; 3) future year simulation for 2020, which was the same as the reference year simulation, except that projected anthropogenic emissions for 2020 were used in lieu of the 2012 emissions. The relative change in ozone from simulation (2) to simulation (3) was calculated for each site location and is termed a relative response factor (RRF). A relevant emissions inventory summary is included as Table 11.

Table 11: Summer emission inventory totals (CEPAM v1.03) for 2012 and 2020. Biogenic emission totals were averaged over May – September 2012.

Western Nevada Non-attainment Area						
Source Category	NOx			ROG		
	2012	2020		2012	2020	
	[tpd]	[tpd]	% diff#	[tpd]	[tpd]	% diff#
Stationary	0.106	0.096	-9.4	0.702	0.785	11.8
Area	0.135	0.138	2.2	1.394	1.515	8.7
On-Road Mobile	3.976	2.160	-45.7	1.793	1.007	-43.8
Other Mobile	0.944	0.738	-21.8	1.327	0.958	-27.8
Total	5.160	3.131	-39.3	5.215	4.265	-18.2
Biogenic	--	--		226.2	226.2	--

% diff denotes percent difference with respect to 2012 emission levels.

The site-specific RRF was then multiplied by the baseline DV from the Grass Valley monitor to predict the future year 2020 DV (Table 12). The RRF approach has been applied in other regions of California's Central Valley including the SJV for the 2007 8-

hour Ozone SIP[23], the 2013 1-hour Ozone SIP[24], and the 2016 8-Hour Ozone SIP[25]. In addition, two peer-reviewed scientific publications (one from Rice University researchers[26] and another from U.S. EPA scientists[27]), which focused primarily on areas outside of California, found that the RRF approach is highly robust in its ability to predict future DVs.

Table 12: Baseline Design Value, modeled RRF, and projected future year (2020) 8-hour ozone Design Values (DV) at the Grass Valley ozone monitoring site in WNNA.

Site Location	Base year Average DV (ppb)	Future Year 2020	
		RRF	Average DV (ppb)
Grass Valley-Litton Building	79.0	0.8571	67

[a]DVs from years 2013, 2014, and 2015 were used to calculate the baseline average DV

Note that the results shown in Table 12 includes a projected future year DV for 2020 utilizing a baseline DV that is based on the average of the 2013, 2014, and 2015 DVs, which is more representative of the recent shift in WNNA DVs. The Grass Valley site was projected to have a future DV of 67 ppb in 2020, which supports attainment of the 75 ppb 8-hour O_3 standard by 2020.

As part of the attainment demonstration, the U.S. EPA[28] also requires analysis of ozone levels outside of the routine monitoring network (i.e., at areas between the monitors) to ensure that all regions within WNNA (even those without a monitor) are in attainment of the standard. This "unmonitored area" analysis combines observed DVs with model based RRFs and ozone spatial gradients to estimate future 2020 DVs in unmonitored areas. Details of how the unmonitored area analysis is performed can be found in the Modeling Protocol and Model Attainment Demonstration Appendices. The unmonitored area analysis in WNNA showed that there are no areas within the region, which have future year 2020 DVs greater than 75 ppb.

[23] 2007 Plan for the 1997 8-Hour Ozone Standard available at http://www.valleyair.org/Air_Quality_Plans/AQ_Final_Adopted_Ozone2007.htm

[24] 2013 Plan for the Revoked 1-Hour Ozone Standard available at http://www.valleyair.org/Air_Quality_Plans/Ozone-OneHourPlan-2013.htm

[25] 2016 Plan for the 2008 8-Hour Ozone Standard available at http://www.valleyair.org/air_quality_plans/Ozone-Plan-2016.htm

[26] Pegues, A.H., D.S. Cohan, A. Digar, C. Douglass, and R.S. Wilson (2012). Efficacy of recent state implementation plans for 8-hour ozone. *Journal of the Air & Waste Management Association*, 62, 252-261

[27] Foley. K., P. Dolwick, C. Hogrefe, H. Simon, B. Timin, and N. Possiel, (2015), Dynamic evaluation of CMAQ part II: Evaluation of relative response factor metrics for ozone attainment demonstrations, Atmospheric Environment, 103: 188–195

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

In summary, photochemical modeling performed as part of this Attainment Plan demonstrates that attainment of 2008 8-hour ozone NAAQS is likely by 2020.

XIII. CONTINGENCY MEASURES

CAA §172(c)(9) requires areas implement contingency measures if they fail to make RFP or fail to attain air quality standards by the required attainment date. CAA §182(c)(9) also requires serious non-attainment areas and above to implement contingency measures if they fail to meet any applicable CAA milestones for the 2008, 8-hour Ozone NAAQS.

Since existing mobile source control measures are projected to continue providing significant emission reductions for many years beyond the 2020 attainment year, this Attainment Plan relies on the continuing emission reduction from those existing mobile source control measures to fulfill the Contingency Measures requirement. These measures will continue to be implemented regardless of the District's attainment status in 2021.

As indicated in Table 13, existing mobile source control regulations will continue reducing the District total VOC emissions between 2020 and 2021 by an estimated 1.80 percent per year, and NOx emission between 2020 and 2021 by about 5.07 percent per year. Such continued emission reductions can ensure that reasonable further progress will continue to be achieved in the event the District fails to attain 2008, 8-hour Ozone NAAQS by the required deadline.

Table 13: Projected VOC and NOx Emissions from 2020 to 2021.

	VOC		NOx	
	2020	2021	2020	2021
On-road Mobile Sources	1.052	0.986	3.361	3.046
Off-road Mobile Sources	3.625	3.607	5.830	5.679
Total	**4.677**	**4.593**	**9.191**	**8.725**
Reduction		**0.084**		**0.466**
Percent Reduction		**1.80%**		**5.07%**

XIV. CONCLUSION

Pursuant to CAA requirements and EPA guidance, CARB and the District conducted many analyses to determine whether timely attainment of 2008, 8-hour Ozone NAAQS as a “Serious” non-attainment area is likely. The results of the modeling provide a strong conclusion that the emission control measures defined by CARB and the District in this Attainment Plan are sufficient to continue reducing O_3 concentrations throughout the District’s Non-attainment Area to meet the 2008, 8-hour Ozone NAAQS by the conclusion of the 2020 O_3 season.

Appendix A

Emission Inventories for 2011, 2012, 2014, 2017, 2020 & 2021

WNNA NOX Inventory - Summer - Grown and Controlled - Tons per Day (From CEPAM Version 1.05)								
SOURCE TYPE	CATEGORY	SUB CATEGORY	2011	2012	2014	2017	2020	2021
STATIONARY	FUEL COMBUSTION	ELECTRIC UTILITIES	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029
STATIONARY	FUEL COMBUSTION	MANUFACTURING AND INDUSTRIAL	0.0002	0.0003	0.0002	0.0002	0.0002	0.0002
STATIONARY	FUEL COMBUSTION	FOOD AND AGRICULTURAL PROCESSING	0.0163	0.0157	0.0149	0.0070	0.0062	0.0059
STATIONARY	FUEL COMBUSTION	SERVICE AND COMMERCIAL	0.0365	0.0362	0.0357	0.0374	0.0389	0.0392
STATIONARY	FUEL COMBUSTION	OTHER (FUEL COMBUSTION)	0.0223	0.0223	0.0223	0.0182	0.0153	0.0153
STATIONARY	WASTE DISPOSAL	SEWAGE TREATMENT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STATIONARY	WASTE DISPOSAL	LANDFILLS	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007
STATIONARY	WASTE DISPOSAL	INCINERATORS	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015
STATIONARY	CLEANING AND SURFACE COATINGS	LAUNDERING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STATIONARY	CLEANING AND SURFACE COATINGS	DEGREASING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STATIONARY	CLEANING AND SURFACE COATINGS	COATINGS AND RELATED PROCESS SOLVENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STATIONARY	CLEANING AND SURFACE COATINGS	PRINTING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STATIONARY	CLEANING AND SURFACE COATINGS	ADHESIVES AND SEALANTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STATIONARY	CLEANING AND SURFACE COATINGS	OTHER (CLEANING AND SURFACE COATINGS)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STATIONARY	PETROLEUM PRODUCTION AND MARKETING	PETROLEUM MARKETING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STATIONARY	INDUSTRIAL PROCESSES	CHEMICAL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STATIONARY	INDUSTRIAL PROCESSES	FOOD AND AGRICULTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STATIONARY	INDUSTRIAL PROCESSES	MINERAL PROCESSES	0.0195	0.0201	0.0216	0.0244	0.0261	0.0263
STATIONARY	INDUSTRIAL PROCESSES	METAL PROCESSES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STATIONARY	INDUSTRIAL PROCESSES	WOOD AND PAPER	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		STATIONARY SOURCE TOTALS	0.0999	0.0997	0.0998	0.0923	0.0918	0.0920
AREAWIDE	SOLVENT EVAPORATION	CONSUMER PRODUCTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AREAWIDE	SOLVENT EVAPORATION	ARCHITECTURAL COATINGS AND RELATED PROCESS SOLVENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AREAWIDE	SOLVENT EVAPORATION	PESTICIDES/FERTILIZERS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AREAWIDE	SOLVENT EVAPORATION	ASPHALT PAVING / ROOFING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AREAWIDE	MISCELLANEOUS PROCESSES	RESIDENTIAL FUEL COMBUSTION	0.1403	0.1300	0.1303	0.1311	0.1327	0.1333
AREAWIDE	MISCELLANEOUS PROCESSES	FARMING OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AREAWIDE	MISCELLANEOUS PROCESSES	CONSTRUCTION AND DEMOLITION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AREAWIDE	MISCELLANEOUS PROCESSES	PAVED ROAD DUST	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AREAWIDE	MISCELLANEOUS PROCESSES	UNPAVED ROAD DUST	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AREAWIDE	MISCELLANEOUS PROCESSES	FUGITIVE WINDBLOWN DUST	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AREAWIDE	MISCELLANEOUS PROCESSES	FIRES	0.0002	0.0002	0.0002	0.0002	0.0003	0.0003
AREAWIDE	MISCELLANEOUS PROCESSES	MANAGED BURNING AND DISPOSAL	0.0047	0.0047	0.0047	0.0047	0.0047	0.0047
AREAWIDE	MISCELLANEOUS PROCESSES	COOKING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AREAWIDE	MISCELLANEOUS PROCESSES	OTHER (MISCELLANEOUS PROCESSES)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		AREAWIDE SOURCE TOTALS	0.1452	0.1349	0.1352	0.1360	0.1377	0.1383
MOBILE	ON-ROAD MOTOR VEHICLES	LIGHT DUTY PASSENGER (LDA)	0.3057	0.2720	0.2219	0.1610	0.1143	0.1041
MOBILE	ON-ROAD MOTOR VEHICLES	LIGHT DUTY TRUCKS - 1 (LDT1)	0.0895	0.0825	0.0669	0.0445	0.0270	0.0237
MOBILE	ON-ROAD MOTOR VEHICLES	LIGHT DUTY TRUCKS - 2 (LDT2)	0.4380	0.3971	0.3360	0.2533	0.1840	0.1662
MOBILE	ON-ROAD MOTOR VEHICLES	MEDIUM DUTY TRUCKS (MDV)	0.3392	0.3133	0.2875	0.2442	0.1965	0.1788
MOBILE	ON-ROAD MOTOR VEHICLES	LIGHT HEAVY DUTY GAS TRUCKS - 1 (LHDGT1)	0.1346	0.1227	0.1103	0.0941	0.0793	0.0747
MOBILE	ON-ROAD MOTOR VEHICLES	LIGHT HEAVY DUTY GAS TRUCKS - 2 (LHDGT2)	0.0090	0.0086	0.0073	0.0056	0.0041	0.0037
MOBILE	ON-ROAD MOTOR VEHICLES	MEDIUM HEAVY DUTY GAS TRUCKS (MHDGT)	0.0164	0.0132	0.0116	0.0092	0.0072	0.0066
MOBILE	ON-ROAD MOTOR VEHICLES	HEAVY HEAVY DUTY GAS TRUCKS (HHDGT)	0.0048	0.0045	0.0038	0.0029	0.0024	0.0023
MOBILE	ON-ROAD MOTOR VEHICLES	LIGHT HEAVY DUTY DIESEL TRUCKS - 1 (LHDDT1)	0.7847	0.7188	0.6477	0.5294	0.3938	0.3531
MOBILE	ON-ROAD MOTOR VEHICLES	LIGHT HEAVY DUTY DIESEL TRUCKS - 2 (LHDDT2)	0.1321	0.1245	0.1093	0.0850	0.0582	0.0506
MOBILE	ON-ROAD MOTOR VEHICLES	MEDIUM HEAVY DUTY DIESEL TRUCKS (MHDDT)	0.2555	0.2174	0.2010	0.1725	0.1399	0.1177
MOBILE	ON-ROAD MOTOR VEHICLES	HEAVY HEAVY DUTY DIESEL TRUCKS (HHDDT)	1.8487	1.5868	1.1842	0.9967	0.8785	0.8155
MOBILE	ON-ROAD MOTOR VEHICLES	MOTORCYCLES (MCY)	0.0286	0.0272	0.0257	0.0243	0.0221	0.0216
MOBILE	ON-ROAD MOTOR VEHICLES	HEAVY DUTY DIESEL URBAN BUSES (UBD)	0.0145	0.0140	0.0122	0.0102	0.0078	0.0072
MOBILE	ON-ROAD MOTOR VEHICLES	HEAVY DUTY GAS URBAN BUSES (UBG)	0.0046	0.0034	0.0030	0.0028	0.0021	0.0021
MOBILE	ON-ROAD MOTOR VEHICLES	SCHOOL BUSES - GAS (SBG)	0.0014	0.0013	0.0006	0.0004	0.0003	0.0002
MOBILE	ON-ROAD MOTOR VEHICLES	SCHOOL BUSES - DIESEL (SBD)	0.0158	0.0158	0.0155	0.0151	0.0126	0.0119
MOBILE	ON-ROAD MOTOR VEHICLES	OTHER BUSES - GAS (OBG)	0.0038	0.0036	0.0030	0.0024	0.0018	0.0016
MOBILE	ON-ROAD MOTOR VEHICLES	OTHER BUSES - MOTOR COACH - DIESEL (OBC)	0.0100	0.0084	0.0074	0.0060	0.0049	0.0045
MOBILE	ON-ROAD MOTOR VEHICLES	ALL OTHER BUSES - DIESEL (OBD)	0.0181	0.0155	0.0138	0.0105	0.0090	0.0081
MOBILE	ON-ROAD MOTOR VEHICLES	MOTOR HOMES (MH)	0.0258	0.0252	0.0226	0.0184	0.0136	0.0122
MOBILE	OTHER MOBILE SOURCES	AIRCRAFT	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054
MOBILE	OTHER MOBILE SOURCES	TRAINS	0.2761	0.2654	0.2478	0.2210	0.1833	0.1748
MOBILE	OTHER MOBILE SOURCES	RECREATIONAL BOATS	0.1450	0.1393	0.1302	0.1217	0.1144	0.1121
MOBILE	OTHER MOBILE SOURCES	OFF-ROAD RECREATIONAL VEHICLES	0.0076	0.0071	0.0069	0.0083	0.0094	0.0097
MOBILE	OTHER MOBILE SOURCES	OFF-ROAD EQUIPMENT	0.3805	0.3792	0.3689	0.3468	0.3155	0.2974
MOBILE	OTHER MOBILE SOURCES	FARM EQUIPMENT	0.1461	0.1402	0.1294	0.1158	0.1012	0.0955
MOBILE	OTHER MOBILE SOURCES	FUEL STORAGE AND HANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		MOBILE SOURCE TOTALS	5.4415	4.9124	4.1799	3.5075	2.8886	2.6613
		GRAND TOTALS	5.6866	5.1470	4.4149	3.7358	3.1181	2.8916

WNNA ROG Inventory - Summer - Grown and Controlled - Tons per Day (From CEPAM Version 1.05)								
SOURCE TYPE	CATEGORY	SUB CATEGORY	2011	2012	2014	2017	2020	2021
STATIONARY	FUEL COMBUSTION	ELECTRIC UTILITIES	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
STATIONARY	FUEL COMBUSTION	MANUFACTURING AND INDUSTRIAL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STATIONARY	FUEL COMBUSTION	FOOD AND AGRICULTURAL PROCESSING	0.0011	0.0011	0.0010	0.0005	0.0004	0.0003
STATIONARY	FUEL COMBUSTION	SERVICE AND COMMERCIAL	0.0009	0.0009	0.0009	0.0009	0.0009	0.0010
STATIONARY	FUEL COMBUSTION	OTHER (FUEL COMBUSTION)	0.0014	0.0014	0.0014	0.0011	0.0008	0.0008
STATIONARY	WASTE DISPOSAL	SEWAGE TREATMENT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STATIONARY	WASTE DISPOSAL	LANDFILLS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STATIONARY	WASTE DISPOSAL	INCINERATORS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STATIONARY	CLEANING AND SURFACE COATINGS	LAUNDERING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STATIONARY	CLEANING AND SURFACE COATINGS	DEGREASING	0.2664	0.2176	0.2290	0.2442	0.2577	0.2638
STATIONARY	CLEANING AND SURFACE COATINGS	COATINGS AND RELATED PROCESS SOLVENTS	0.1068	0.0957	0.0968	0.0998	0.1035	0.1054
STATIONARY	CLEANING AND SURFACE COATINGS	PRINTING	0.0841	0.0873	0.0929	0.0969	0.1001	0.1012
STATIONARY	CLEANING AND SURFACE COATINGS	ADHESIVES AND SEALANTS	0.0507	0.0514	0.0528	0.0569	0.0599	0.0606
STATIONARY	CLEANING AND SURFACE COATINGS	OTHER (CLEANING AND SURFACE COATINGS)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
STATIONARY	PETROLEUM PRODUCTION AND MARKETING	PETROLEUM MARKETING	0.1548	0.1481	0.1460	0.1431	0.1359	0.1334
STATIONARY	INDUSTRIAL PROCESSES	CHEMICAL	0.0806	0.0814	0.0869	0.0965	0.1053	0.1085
STATIONARY	INDUSTRIAL PROCESSES	FOOD AND AGRICULTURE	0.0028	0.0028	0.0030	0.0032	0.0033	0.0034
STATIONARY	INDUSTRIAL PROCESSES	MINERAL PROCESSES	0.0121	0.0126	0.0135	0.0153	0.0162	0.0165
STATIONARY	INDUSTRIAL PROCESSES	METAL PROCESSES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STATIONARY	INDUSTRIAL PROCESSES	WOOD AND PAPER	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		STATIONARY SOURCE TOTALS	0.7620	0.7006	0.7245	0.7587	0.7843	0.7952
AREAWIDE	SOLVENT EVAPORATION	CONSUMER PRODUCTS	0.4685	0.4492	0.4237	0.4281	0.4367	0.4400
AREAWIDE	SOLVENT EVAPORATION	ARCHITECTURAL COATINGS AND RELATED PROCESS SOLVENTS	0.3141	0.3137	0.3118	0.3143	0.3208	0.3231
AREAWIDE	SOLVENT EVAPORATION	PESTICIDES/FERTILIZERS	0.0160	0.0106	0.0172	0.0131	0.0131	0.0131
AREAWIDE	SOLVENT EVAPORATION	ASPHALT PAVING / ROOFING	0.2521	0.2617	0.2825	0.3394	0.3815	0.3905
AREAWIDE	MISCELLANEOUS PROCESSES	RESIDENTIAL FUEL COMBUSTION	0.1435	0.1427	0.1420	0.1430	0.1459	0.1470
AREAWIDE	MISCELLANEOUS PROCESSES	FARMING OPERATIONS	0.1181	0.1181	0.1181	0.1181	0.1181	0.1181
AREAWIDE	MISCELLANEOUS PROCESSES	CONSTRUCTION AND DEMOLITION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AREAWIDE	MISCELLANEOUS PROCESSES	PAVED ROAD DUST	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AREAWIDE	MISCELLANEOUS PROCESSES	UNPAVED ROAD DUST	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AREAWIDE	MISCELLANEOUS PROCESSES	FUGITIVE WINDBLOWN DUST	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AREAWIDE	MISCELLANEOUS PROCESSES	FIRES	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
AREAWIDE	MISCELLANEOUS PROCESSES	MANAGED BURNING AND DISPOSAL	0.0878	0.0878	0.0878	0.0878	0.0878	0.0878
AREAWIDE	MISCELLANEOUS PROCESSES	COOKING	0.0100	0.0100	0.0100	0.0101	0.0103	0.0103
AREAWIDE	MISCELLANEOUS PROCESSES	OTHER (MISCELLANEOUS PROCESSES)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		AREAWIDE SOURCE TOTALS	1.4109	1.3946	1.3939	1.4547	1.5150	1.5307
MOBILE	ON-ROAD MOTOR VEHICLES	LIGHT DUTY PASSENGER (LDA)	0.5001	0.4478	0.3494	0.2463	0.1787	0.1659
MOBILE	ON-ROAD MOTOR VEHICLES	LIGHT DUTY TRUCKS - 1 (LDT1)	0.1752	0.1656	0.1326	0.0890	0.0573	0.0526
MOBILE	ON-ROAD MOTOR VEHICLES	LIGHT DUTY TRUCKS - 2 (LDT2)	0.4549	0.4325	0.3814	0.3150	0.2641	0.2513
MOBILE	ON-ROAD MOTOR VEHICLES	MEDIUM DUTY TRUCKS (MDV)	0.2737	0.2650	0.2560	0.2382	0.2189	0.2095
MOBILE	ON-ROAD MOTOR VEHICLES	LIGHT HEAVY DUTY GAS TRUCKS - 1 (LHDGT1)	0.1216	0.1141	0.1065	0.0972	0.0872	0.0837
MOBILE	ON-ROAD MOTOR VEHICLES	LIGHT HEAVY DUTY GAS TRUCKS - 2 (LHDGT2)	0.0067	0.0067	0.0058	0.0047	0.0030	0.0026
MOBILE	ON-ROAD MOTOR VEHICLES	MEDIUM HEAVY DUTY GAS TRUCKS (MHDGT)	0.0199	0.0153	0.0093	0.0058	0.0042	0.0039
MOBILE	ON-ROAD MOTOR VEHICLES	HEAVY HEAVY DUTY GAS TRUCKS (HHDGT)	0.0031	0.0028	0.0018	0.0009	0.0008	0.0006
MOBILE	ON-ROAD MOTOR VEHICLES	LIGHT HEAVY DUTY DIESEL TRUCKS - 1 (LHDDT1)	0.0318	0.0302	0.0288	0.0252	0.0199	0.0182
MOBILE	ON-ROAD MOTOR VEHICLES	LIGHT HEAVY DUTY DIESEL TRUCKS - 2 (LHDDT2)	0.0056	0.0056	0.0053	0.0046	0.0036	0.0033
MOBILE	ON-ROAD MOTOR VEHICLES	MEDIUM HEAVY DUTY DIESEL TRUCKS (MHDDT)	0.0227	0.0196	0.0170	0.0113	0.0059	0.0031
MOBILE	ON-ROAD MOTOR VEHICLES	HEAVY HEAVY DUTY DIESEL TRUCKS (HHDDT)	0.1500	0.1222	0.0641	0.0378	0.0277	0.0267
MOBILE	ON-ROAD MOTOR VEHICLES	MOTORCYCLES (MCY)	0.1561	0.1520	0.1442	0.1374	0.1307	0.1285
MOBILE	ON-ROAD MOTOR VEHICLES	HEAVY DUTY DIESEL URBAN BUSES (UBD)	0.0008	0.0007	0.0006	0.0005	0.0004	0.0003
MOBILE	ON-ROAD MOTOR VEHICLES	HEAVY DUTY GAS URBAN BUSES (UBG)	0.0013	0.0010	0.0009	0.0007	0.0006	0.0006
MOBILE	ON-ROAD MOTOR VEHICLES	SCHOOL BUSES - GAS (SBG)	0.0020	0.0015	0.0004	0.0001	0.0000	0.0000
MOBILE	ON-ROAD MOTOR VEHICLES	SCHOOL BUSES - DIESEL (SBD)	0.0014	0.0012	0.0003	0.0003	0.0002	0.0002
MOBILE	ON-ROAD MOTOR VEHICLES	OTHER BUSES - GAS (OBG)	0.0019	0.0018	0.0015	0.0009	0.0009	0.0008
MOBILE	ON-ROAD MOTOR VEHICLES	OTHER BUSES - MOTOR COACH - DIESEL (OBC)	0.0009	0.0006	0.0003	0.0002	0.0001	0.0001
MOBILE	ON-ROAD MOTOR VEHICLES	ALL OTHER BUSES - DIESEL (OBD)	0.0016	0.0012	0.0007	0.0003	0.0002	0.0002
MOBILE	ON-ROAD MOTOR VEHICLES	MOTOR HOMES (MH)	0.0050	0.0048	0.0039	0.0027	0.0017	0.0014
MOBILE	OTHER MOBILE SOURCES	AIRCRAFT	0.0486	0.0486	0.0486	0.0486	0.0486	0.0486
MOBILE	OTHER MOBILE SOURCES	TRAINS	0.0180	0.0164	0.0130	0.0095	0.0065	0.0062
MOBILE	OTHER MOBILE SOURCES	RECREATIONAL BOATS	0.7501	0.7124	0.6396	0.5516	0.4715	0.4461
MOBILE	OTHER MOBILE SOURCES	OFF-ROAD RECREATIONAL VEHICLES	0.1633	0.1532	0.1392	0.1339	0.1254	0.1221
MOBILE	OTHER MOBILE SOURCES	OFF-ROAD EQUIPMENT	0.3064	0.2958	0.2703	0.2456	0.2336	0.2342
MOBILE	OTHER MOBILE SOURCES	FARM EQUIPMENT	0.0335	0.0321	0.0284	0.0243	0.0202	0.0192
MOBILE	OTHER MOBILE SOURCES	FUEL STORAGE AND HANDLING	0.0665	0.0624	0.0557	0.0488	0.0440	0.0427
		MOBILE SOURCE TOTALS	3.3227	3.1131	2.7056	2.2814	1.9559	1.8726
		GRAND TOTALS	5.4956	5.2083	4.8240	4.4948	4.2552	4.1985

Appendix B

CARB Control Measures, 1985 to 2016

CARB Control Measures, 1985 to 2016

Board Action	Hearing Date
Public Meeting to Consider the Proposed Amendments to the Evaporative Emission Requirements for Small Off-Road Engines: The proposed amendments will address to non-compliance of small off-road engines (SORE) with existing evaporative emission standards, as well as amendments to streamline the certification process by harmonizing where feasible with federal requirements.	11/17/16
Notice of Public Hearing to Consider Proposed Regulation to Provide Certification Flexibility for Innovative Heavy-Duty Engine and California Certification and Installation Procedures for Medium and Heavy-Duty Vehicle Hybrid Conversion Systems: This proposed regulation's certification flexibility is tailored to encourage development and market launch of heavy-duty engines meeting California's optional low oxides of oxides of nitrogen emission standards, robust heavy-duty hybrid engines, and high-efficiency heavy-duty engines.	10/20/16
Notice of Public Hearing to Consider Amendments to the California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms Regulations: The proposed amendments would extend major provisions of the Regulation beyond 2020; link the Regulation with Ontario, Canada; continue cost-effective prevention of emission leakage through allowance allocations to entities; and enhance Program implementation and oversight.	9/22/16
Notice of Public Hearing to Consider Proposed Amendments to the Mandatory Reporting of Greenhouse Gas Emissions: The proposed amendments are to ensure reported GHG data are accurate and fully support the California Cap on Greenhouse Gas Emissions and Market Based Compliance Mechanisms and comply with the U.S. EPA Clean Power Plan.	9/22/16
Public Hearing to Consider Proposed Amendments to the Large Spark-Ignition Engine Fleet Requirements Regulation: The proposed amendment will establish new reporting and labeling requirements and extend existing recordkeeping requirements. The proposed regulatory amendments are expected to improve the reliability of the emission reductions projected for the existing LSI Fleet Regulation by increasing enforcement effectiveness and compliance rates.	7/21/16
Public Hearing to Consider Proposed Evaluation Procedure for New Aftermarket Diesel Particulate Filters Intended as Modified Parts for 2007 through 2009 Model Year On-Road Heavy-Duty Diesel Engines: The proposed amendment would establish a path for exempting aftermarket modified part DPFs intended for 2007 through 2009 on-road heavy-duty diesel engines from the prohibitions of the current vehicle code. Staff is also proposing to incorporate a new procedure for the evaluation of such DPFs.	4/22/16
Public Hearing to Consider Proposed Amendments to the Regulation for Small Containers of Automotive Refrigerant: The proposed amendments to the Regulation for Small Containers of Automotive Refrigerant to clarify any existing requirement that retailers must transfer the unclaimed consumer deposits to the manufacturers, clarify how the manufacturers spend the money, set the refundable consumer deposit at $10, and require additional language on the container label.	4/22/16
Amendments to the Portable Fuel Container Regulation Amendments to the Portable Fuel Container (PFC) regulation, which include requiring certification fuel to contain 10 percent ethanol, harmonizing aspects of the Board's PFC certification and test procedures with those of the U.S. EPA, revising the ARB's certification process, and streamlining, clarifying, and increasing the robustness of ARB's certification and test procedures.	2/18/16

Board Action	Hearing Date
Technical Status and Proposed Revisions to On-Board Diagnostic System Requirements and Associated Enforcement Provisions for Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines (OBD II) Amendments to the OBD II regulations that update requirements to account for LEV III applications and monitoring requirements for gasoline and diesel vehicles, and clarify and improve the regulation; also, updates to the associated OBD II enforcement regulation to align it with the proposed amendments to the OBD II regulations and a minor amendment to the definition of "emissions-related part" in title 13, CCR section 1900.	9/25/15
2015 Low Carbon Fuel Standard (LCFS) Amendments (2 of 2) Re-adoption of the Low Carbon Fuel Standard, which includes updates and revisions to the regulation now in effect. The proposed regulation was first presented to the Board at its February 2015 public hearing, at which the Board directed staff to make modifications to the proposal.	9/24/15
Proposed Regulation on the Commercialization of Alternative Diesel Fuels (2 of 2) Regulation governing the introduction of alternative diesel fuels into the California commercial market, including special provisions for biodiesel.	9/24/15
CA Cap on GHG Emissions and Market-Based Compliance Mechanisms (2 of 2) Amendments to the Cap and Trade Regulation to include a new Rice Cultivation Compliance Offset Protocol and an update to the United States Forest Compliance Offset Protocol that would include project eligibility in parts of Alaska.	6/25/15
Intermediate Volume Manufacturer Amendments to the Zero Emission Vehicle Regulation (2 of 2) Amendments regarding intermediate volume manufacturer compliance obligations under the Zero Emission Vehicle regulation.	5/21/15
2015 Amendments to Certification Procedures for Vapor Recovery Systems at Gasoline Dispensing Facilities—Aboveground Storage Tanks and Enhanced Conventional Nozzles Amendments would establish new performance standards and specifications for nozzles used at fleet facilities that exclusively refuel vehicles equipped with onboard vapor recovery systems, would provide regulatory relief for owners of certain existing aboveground storage tanks, and would ensure that mass-produced vapor recovery equipment matches the specifications of equipment evaluated during the ARB certification process.	4/23/15
Proposed Regulation for the Commercialization of Alternative Diesel Fuels (1 of 2) Regulation governing the introduction of alternative diesel fuels into the California commercial market, including special provisions for biodiesel. This is the first of two hearings on the item, and the Board will not take action to approve the proposed regulation.	2/19/15
Evaporative Emission Control Requirements for Spark-Ignition Marine Watercraft Regulation for controlling evaporative emissions from spark-ignition marine watercraft. The proposed regulation will harmonize, to the extent feasible, with similar federal requirements, while adding specific provisions needed to support California's air quality needs.	2/19/15
2015 Low Carbon Fuel Standard (LCFS) Amendments (1 of 2) Regulation for a Low Carbon Fuel Standard that includes re- adoption of the existing Low Carbon Fuel Standard with updates and revisions. This is the first of two hearings on the item, and the Board will not take action to approve the proposed regulation.	2/19/15
CA Cap on GHG Emissions and Market-Based Compliance Mechanisms to Add the Rice Cultivation Projects and Updated U.S. Forest Projects Protocols (1 of 2) Updates to the Cap and Trade Regulation to include a new Rice Cultivation Compliance Offset Protocol and an update to the United States Forest Compliance Offset Protocol that would include project eligibility in parts of Alaska.	12/18/14
2014 Amendments to ZEV Regulation Additional compliance flexibility to ZEV manufacturers working to bring advanced technologies to market.	10/23/14
LEV III Criteria Pollutant Requirements for Light- and Medium-Duty Vehicles the Hybrid Electric Vehicle Test Procedures, and the HD Otto-Cycle and HD Diesel Test Procedures Applies to the 2017 and subsequent model years.	10/23/14

Board Action	Hearing Date
Amendments to Mandatory Reporting Regulation for Greenhouse Gases Further align reporting methods with USEPA methods and factors, and modify reporting requirements to fully support implementation of California's Cap and Trade program.	9/19/14
Amendments to the California Cap on Greenhouse Gas Emissions and Market Based Compliance Mechanisms Technical revisions to Mandatory Reporting of Greenhouse Gas Emissions Regulation to further align reporting methods with U.S.EPA update methods and factors, and modify reporting requirements to fully support implementation of California's Cap and Trade program.	9/18/14
Amendments to the AB 32 Cost of Implementation Fee Regulation Amendments to the regulation to make it consistent with the revised mandatory reporting regulation, to add potential reporting requirements, and to incorporate requirements within the mandatory reporting regulation to streamline reporting.	9/18/14
Low Carbon Fuel Standard 2014 Update As a result of a California Court of Appeal decision, ARB will revisit the LCFS rulemaking process to meet certain procedural requirements of the APA and CEQA. Following incorporation of any modifications to the regulation, the Board will consider the proposed regulation for adoption at a second hearing held in the spring of 2015.	7/24/14
Revisions to the Carl Moyer Memorial Air Quality Standards Attainment Program Guidelines for On-Road Heavy-Duty Trucks Revisions to 1) reduce surplus emission reduction period, 2) reduce minimum CA usage requirement, 3) prioritize on-road funding to small fleets, 4) include light HD vehicles 14000-19500 libs, and 5) clarify program specifications.	7/24/14
Amendments to Enhanced Fleet Modernization (Car Scrap) Program Amendments consistent with SB 459 which requires ARB to increase benefits for low-income California residents, promote cleaner replacement vehicles, and enhance emissions reductions.	6/26/14
Proposed Approval of Amendments to CA Cap on GHG Emissions and Market-Based Compliance Mechanisms Second hearing of two, continued from October 2013.	4/24/14
Truck and Bus Rule Update Amendments to the Regulation to Reduce Emissions of Diesel Particulate Matter, Oxides of Nitrogen, and Other Criteria Pollutants From In-Use On-Road Diesel-Fueled Vehicles: increasing low-use vehicle thresholds, allowing owners to newly opt-in to existing flexibility provisions, adjusting "NOx exempt" vehicle provisions, and granting additional time for fleets in certain areas to meet PM filter requirements.	4/24/14
Heavy-Duty GHG Phase I: On-Road Heavy-Duty GHG Emissions Rule, Tractor-Trailer Rule, Commercial Motor Vehicle Idling Rule, Optional Reduced Emission Standards, Heavy-Duty Hybrid-Electric Vehicles Certification Procedure New GHG standards for MD and HD engines and vehicles identical to those adopted by the USEPA in 2011 for MYs 2014-18.	12/12/13
Agricultural equipment SIP credit rule Incentive-funded projects must be implemented using Carl Moyer Program Guidelines; must be surplus, quantifiable, enforceable, and permanent, and result in emission reductions that are eligible for SIP credit.	10/25/13
Mandatory Report of Greenhouse Gas Emissions Approved a regulation that establishes detailed specifications for emissions calculations, reporting, and verification of GHG emission estimates from significant sources.	10/25/13
CA Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms Technical revisions to the Mandatory Reporting of Greenhouse Gas Emissions Regulation to further align reporting methods with U.S.EPA, update factors, and modify definitions to maintain consistency with the Cap and Trade program.	10/25/13

Board Action	Hearing Date
Zero emission vehicle test procedures Existing certification test procedures for plug-in hybrid vehicles need to be updated to reflect technology developments. The ZEV regulation will require minor modifications to address clarity and implementation issues.	10/24/13
Consumer Products: Antiperspirants, Deodorants, Test Method 310, Aerosol Coatings, Proposed Repeal of Hairspray Credit) Amendments to require various consumer products to reformulate to reduce VOC or reactivity content to meet specified limits, and to clarify various regulatory provisions, improve enforcement, and add analytical procedures.	9/26/13
Alternative fuel certification procedures Amendments to current alternative fuel conversion certification procedures for motor vehicles and engines that will allow small volume conversion manufacturers to reduce the upfront demonstration requirements and allow systems to be sold sooner with lower certification costs than with the current process, beginning with MY 2018.	9/26/13
Vapor Recovery for Gasoline Dispensing Facilities Amendments to certification and test procedures for vapor recovery equipment used on cargo tanks and at gasoline dispensing facilities.	7/25/13
Off-highway recreational vehicle evaporative emission control Staff proposes to set evaporative emission standards to control hydrocarbon emissions from Off-Highway Recreational Vehicles. The running loss, hot soak, and diurnal performance standards can be met by using proven automobile type control technology.	7/25/13
Gasoline and diesel fuel test standards Adopted amendments to add test standards for the measurement of prohibited oxygenates at trace levels specified in existing regulations.	1/25/13
LEV III and ZEV Programs for Federal Compliance Option Adopted amendments to deem compliance with national GHG new vehicle standards in 2017-2025 as compliance with California GHG standards for the same model years.	11/15/12 12/6/12 EO
Consumer products (automotive windshield washing fluid) Adopted amendments to add portions of 14 California counties to the list of areas with freezing temperatures where 25% VOC content windshield washing fluid could be sold.	10/18/2012 EO 03/15/13
GHG mandatory reporting, Fee Regulation, and Cap and Trade 2012 Adopted amendments to eliminate emission verification for facilities emitting less than 25,000 MTCO2e and make minor changes in definitions and requirements.	9/20/12 11/2/12 EO
Amendments to Verification Procedure, Warranty and In-Use Compliance Requirements for In-Use Strategies to Control Emissions from Diesel Engines Approved amendments to the verification procedure used to evaluate diesel retrofits through emissions, durability, and field testing. Amendments will lower costs associated with required in-use compliance testing, streamline the in-use compliance process, and will extend time allowed to complete verifications.	8/23/2012 EO 07/02/13
Amendments to On-Board Diagnostics (OBD I and II) Regulations Approved amendments to the light- and medium-duty vehicle and heavy-duty engine OBD regulations.	8/23/2012 EO 06/26/13
Cap and Trade: Amendments to CA Cap on GHG Emissions and Market-Based Compliance Mechanisms, and Amendments Allowing Use of Compliance Instruments Issued by Linked Jurisdictions Amends Cap-and-Trade and compliance mechanisms to add security to the market system and to aid staff in implementation. Amendments include first auction rules, offset registry, market monitoring provisions, and information gathering necessary for the financial services operator.	6/28/12 7/31/12 EO
Vapor recovery defect list Adopted amendments to add defects and verification procedures for equipment approved since 2004, and make minor changes to provide clarity	6/11/12 EO

Board Action	Hearing Date
Tractor-Trailer GHG Regulation: Emergency Amendment Adopted emergency amendment to correct a drafting error and delay the registration date for participation in the phased compliance option	2/29/2012 2/29/12 EO
Advanced Clean Cars (ACC) Regulation: Low-Emission Vehicles and GHG Adopted more stringent criteria emission standards for MY 2015-2025 light and medium duty vehicles (LEV III), amended GHG emission standards for model year 2017-2025 light and medium duty vehicles (LEV GHG), amended ZEV Regulation to ensure the successful market penetration of ZEVs in commercial volumes, amended hydrogen fueling infrastructure mandate of the Clean Fuels Outlet regulation, and amended cert fuel for light duty vehicles from an MTBE-containing fuel to an E10 certification fuel.	1/26/12
Zero Emission Vehicle (ZEV) Adopted amendments to increase compliance flexibility, add two new vehicle categories for use in creating credits, increase credits for 300 mile FCVs, increase requirements for ZEVs and TZEVs, eliminate credit for PZEVs and AT PZEVs, expand applicability to smaller manufacturers, base ZEV credits on range, and make other minor changes in credit requirements	1/26/12
Amendments to Low Carbon Fuel Standard Regulation The amendments address several aspects of the regulation, including: reporting requirements, credit trading, regulated parties, opt-in and opt-out provisions, definitions, and other clarifying language.	12/16/11 10/10/12 EO
Amendments to Small Off-Road Engine and Tier 4 Off-Road Compression-Ignition Engine Regulations And Test Procedures; also "Recreational Marine" Spark-Ignition Marine Engine Amendments (Recreational Boats) adopted. Aligns California test procedures with U.S. EPA test procedures and requires off-road CI engine manufacturers to conduct in-use testing of their entire product lines to confirm compliance with previously established Not-To-Exceed emission thresholds.	12/16/2011 10/25/12 EO
Regulations and Certification Procedures for Engine Packages used in Light-Duty Specially Constructed Vehicles (Kit Cars) Ensures that certified engine packages, when placed into any Kit Car, would meet new vehicle emission standards, and be able to meet Smog Check requirements.	11/17/11 9/21/12 EO
Amendments to the California Reformulated Gasoline Regulations Corrects drafting errors in the predictive model, deletes outdated regulatory provisions, updates the notification requirements, and changes the restrictions on blending CARBOB with other liquids.	10/21/11 8/24/12 EO
Amendments to the In-Use Diesel Transport Refrigeration Units (TRU) ATCM Mechanisms to improve compliance rates and enforceability.	10/21/11 8/31/12 EO
Amendments to the AB 32 Cost of Implementation Fee Regulation Clarifies requirements and regulatory language, revises definitions.	10/20/11 8/21/12 EO
Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms Regulation, Including Compliance Offset Protocols Greenhouse Gas Emissions Cap-and-Trade Program, including compliance offset protocols and multiple pathways for compliance.	10/21/11 8/21/12 EO
Amendments to the Regulation for Cargo Handling Equipment (CHE) at Ports and Intermodal Rail Yards (Port Yard Trucks Regulation) Provides additional compliance flexibility, and maintains anticipated emissions reductions. As applicable to yard trucks and two-engine sweepers.	9/22/11 8/2/12 EO
Amendments to the Enhanced Vapor Recovery Regulation for Gasoline Dispensing Facilities New requirement for low permeation hoses at gasoline dispensing facilities.	9/22/11 7/26/12 EO
Amendments to Cleaner Main Ship Engines and Fuel for Ocean-Going Vessels Adjusts the offshore regulatory boundary. Aligns very low sulfur fuel implementation deadlines with new federal requirements.	6/23/11 9/13/12 EO

Board Action	Hearing Date
Particulate Matter Emissions Measurement Allowance For Heavy-Duty Diesel In-Use Compliance Regulation Emission measurement allowances provide for variability associated with the field testing required in the regulation.	6/23/11
Low Carbon Fuel Standard Carbon Intensity Lookup Table Amendments Adds new pathways for vegetation-based fuels	2/24/11
Amendments to Cleaner In-Use Heavy-Duty On-Road Diesel Trucks and LSI Fleets Regulations Amends five regulations to provide relief to fleets adversely affected by the economy, and take into account the fact that emissions are lower than previously predicted.	12/16/10 9/19/11 EO
Tractor-Trailer GHG Regulation Amendment Enacts administrative changes to increase compliance flexibility and reduce costs	12/16/10
Amendments to Cleaner In-Use Off-Road Diesel-Fueled Fleets Regulation Amendments provide relief to fleets adversely affected by the economy, and take into account the fact that emissions are lower than previously predicted.	12/16/10 10/28/11 EO
In-Use On-Road Diesel-Fueled Heavy-Duty Drayage Trucks at Ports and Rail Yard Facilities Amendments add flexibility to fleets' compliance schedules, mitigate the use of noncompliant trucks outside port and rail properties, and provide transition to the Truck and Bus regulation.	12/16/10 9/19/11 EO
Amendments to the Regulation for Mandatory Reporting of Greenhouse Gas Emissions Changes requirements to align with federal greenhouse gas reporting requirements adopted by US EPA.	12/16/10 10/28/11 EO
Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms Regulation Establishes framework and requirements for Greenhouse Gas Emissions Cap-and-Trade Program, including compliance offset protocols.	12/16/10 10/26/11 EO
Amendments to the Consumer Products Regulation Amendments set new or lower VOC limits for some categories, prohibit certain toxic air contaminants, high GWP compounds, and surfactants toxic to aquatic species. Also changes Method 310, used to determine aromatic content of certain products.	11/18/10 9/29/11 EO
Amendment of the ATCM for Diesel Transportation Refrigeration Units (TRU) Amendments expand the compliance options and clarify the operational life of various types of TRUs.	11/18/10 2/2/11 EO
Amendments to the ATCM for Stationary Compression Ignition Engines Approved amendments to closely align the emission limits for new emergency standby engines in the ATCM with the emission standards required by the federal Standards of Performance.	10/21/10 3/25/11 EO
Diesel Vehicle Periodic Smoke Inspection Program Adopted amendments to exempt medium duty diesel vehicles from smoke inspection requirements if complying with Smog Check requirements.	10/21/10 8/23/11 EO
Renewable Electricity Standard Regulation Approved a regulation that will require electricity providers to obtain at least 33% of their retail electricity sales from renewable energy resources by 2020.	9/23/10
Energy Efficiency at Industrial Facilities Adopted standards for the reporting of GHG emissions and the feasibility of emissions controls by the largest GHG-emitting stationary sources.	7/22/10 5/9/11 EO
Amendments to Commercial Harbor Craft Regulation Approved amendments to require the use of cleaner engines in diesel-fueled crew and supply, barge, and dredge vessels.	6/24/10 4/11/11 EO
Accelerated Introduction of Cleaner Line-Haul Locomotives Agreement with railroads sets prescribed reductions in diesel risk and target years through 2020 at four major railyards.	6/24/10
Amendments to New Passenger Motor Vehicle Greenhouse Gas Emission Standards Approved amendments deeming compliance with EPA's GHG standards as compliance with California's standards in 2012 through 2016 model years.	2/25/2010 03/29/10

Board Action	Hearing Date
Sulfur Hexafluoride (SF6) Regulation Regulation to reduce emissions of sulfur hexafluoride (SF6), a high-GWP GHG, from high-voltage gas-insulated electrical switchgear.	2/25/10 12/15/10 EO
Amendments to the Statewide Portable Equipment Registration Regulation and Portable Engine ATCM Approved amendments that extend the deadline for removal of certain uncertified portable engines for one year.	1/28/10 8/27/10 EO 12/8/10 EO
Diesel Engine Retrofit Control Verification, Warranty, and Compliance Regulation Amendments Approved amendments to require per-installation compatibility assessment, performance data collection, and reporting of additional information, and enhance enforceability.	1/28/10 12/6/10 EO
Stationary Equipment High-GWP Refrigerant Regulation Approved a regulation to reduce emissions of high-GWP refrigerants from stationary non-residential equipment.	12/1/09 9/14/10 EO
Amendments to Limit Ozone Emissions from Indoor Air Cleaning Devices Adopted amendments to delay the labeling compliance deadlines by one to two years and to make minor changes in testing protocols.	12/9/09
Emission Warranty Information Reporting Regulation Amendments Repealed the 2007 regulation and readopted the 1988 regulation with amendments to implement adverse court decision.	11/19/09 9/27/10 EO
Amendments to Maximum Incremental Reactivity Tables Added many new compounds and modified reactivity values for many existing compounds in the tables to reflect new research data.	11/3/09 7/23/10 EO
AB 32 Cost of Implementation Fee Regulation AB 32 authorizes ARB to adopt by regulation a schedule of fees to be paid by sources of greenhouse gas emissions regulated pursuant to AB 32. ARB staff will propose a fee regulation to support the administrative costs of AB 32 implementation.	9/24/2009 05/06/10 EO
Passenger Motor Vehicle Greenhouse Gas Limits Amendments Approved amendments granting credits to manufacturers for compliant vehicles sold in other states that have adopted California regulations.	9/24/09 2/22/10 EO
Consumer Products Amendments Approved amendments that set new VOC limits for multi-purpose solvent and paint thinner products and lower the existing VOC limit for double phase aerosol air fresheners.	9/24/09 8/6/10 EO
Amendments to In-Use Off-Road Diesel-Fueled Fleets Regulation Approved amendments to implement legislatively directed changes and provide additional incentives for early action.	7/23/09 12/2/09 EO 6/3/10 EO
Methane Emissions from Municipal Solid Waste Landfills Approved a regulation to require smaller and other uncontrolled landfills to install gas collection and control systems, and also requires existing and newly installed systems to operate optimally.	6/25/09 5/5/10 EO
Cool Car Standards Approved a regulation requiring the use of solar management window glass in vehicles up to 10,000 lb GVWR.	6/25/09
Enhanced Fleet Modernization (Car Scrap) Approved guidelines for a program to scrap up to 15,000 light duty vehicles statewide.	6/25/09 7/30/10 EO
Amendments to Heavy-Duty On-Board Diagnostics Regulations Approved amendments to the light and medium-duty vehicle and heavy duty engine OBD regulations.	5/28/2009 4/6/10 EO
Smog Check Improvements BAR adopted amendments to implement changes in state law and SIP commitments adopted by ARB between 1996 and 2007.	5/7/09 By BAR 6/9/09 EO

Board Action	Hearing Date
AB 118 Air Quality Improvement Program Guidelines The Air Quality Improvement Program provides for up to $50 million per year for seven years beginning in 2009-10 for vehicle and equipment projects that reduce criteria pollutants, air quality research, and advanced technology workforce training. The AQIP Guidelines describe minimum administrative, reporting, and oversight requirements for the program, and provide general criteria for how the program shall be implemented.	04/23/09 08/28/09 EO
Pesticide Element Reduce volatile organic compound (VOC) emissions from the application of agricultural field fumigants in the South Coast, Southeast Desert, Ventura County, San Joaquin Valley, and Sacramento Metro federal ozone non-attainment areas.	4/20/09 10/12/09 EO (2) 8/2/11 EO
Low Carbon Fuel Standard Approved new standards to lower the carbon content of fuels.	4/20/09 11/25/09 EO
Pesticide Element for San Joaquin Valley DPR Director approved pesticide ROG emission limit of 18.1 tpd and committed to implement restrictions on non-fumigant pesticide use by 2014 in the San Joaquin Valley.	4/7/09 DPR
Tire Pressure Inflation Regulation Approved a regulation requiring automotive service providers to perform tire pressure checks as part of every service.	3/26/09 2/4/10 EO
Sulfur Hexafluoride from Non-Utility and Non-Semiconductor Applications Approved a regulation to phase out use of Sulfur Hexafluoride over the next several years.	2/26/09 11/12/09 EO
Semiconductor Operations Approved a regulation to set standards to reduce fluorinated gas emissions from the semiconductor and related devices industry.	2/26/09 10/23/09 EO
Plug-In Hybrid Electric Vehicles Test Procedure Amendments Amends test procedures to address plug-in-hybrid electric vehicles.	1/23/09 12/2/09 EO
In-Use Off-Road Diesel-Fueled Fleets Amendments Makes administrative changes to recognize delays in the supply of retrofit control devices.	1/22/09
Small Containers of Automotive Refrigerant Approved a regulation to reduce leakage from small containers, adopt a container deposit and return program, and require additional container labeling and consumer education requirements.	1/22/09 1/5/10 EO
Aftermarket Critical Emission Parts on Highway Motorcycles Allows for the sale of certified critical emission parts by aftermarket manufacturers.	1/22/09 6/19/09 EO
Heavy-Duty Tractor-Trailer Greenhouse Gas (GHG) Reduction Approved a regulation to reduce greenhouse gas emissions by improving long haul tractor and trailer efficiency through use of aerodynamic fairings and low rolling resistance tires.	12/11/08 10/23/09 EO
Cleaner In-Use Heavy-Duty Diesel Trucks (Truck and Bus Regulation) Approved a regulation to reduce diesel particulate matter and oxides of nitrogen through fleet modernization and exhaust retrofits. Makes enforceability changes to public fleet, off-road equipment, and portable equipment regulations.	12/11/08 10/19/09 EO 10/23/09 EO
Large Spark-Ignition Engine Amendments Approved amendments to reduce evaporative, permeation, and exhaust emissions from large spark-ignition (LSI) engines equal to or below 1 liter in displacement.	11/1/08 3/12/09 EO
Small Off-Road Engine (SORE) Amendments Approved amendments to address the excessive accumulation of emission credits.	11/21/08 2/24/10 EO
Proposed AB 118 Air Quality Guidelines for the Air Quality Improvement Program and the Alternative and Renewable Fuel and Vehicle and Technology Program. The California Alternative and Renewable Fuel, Vehicle Technology, Clean Air, and Carbon Reduction Act of 2007 (AB 118) requires ARB to develop guidelines for both the Alternative and Renewable Fuel and Vehicle Technology Program and the Air Quality Improvement Program to ensure that both programs do not adversely impact air quality.	09/25/08 EO 05/20/09

Board Action	Hearing Date
Portable Outboard Marine Tanks and Components (part of Additional Evaporative Emission Standards) Approved a regulation that establishes permeation and emission standards for new portable outboard marine tanks and components.	9/25/08 7/20/09 EO
Cleaner Fuel in Ocean Going Vessels Approved a regulation that requires use of low sulfur fuel in ocean-going ship main engines, and auxiliary engines and boilers.	7/24/08 4/16/09 EO
Spark-Ignition Marine Engine and Boat Amendments Provides optional compliance path for > 500 hp sterndrive/inboard marine engines.	7/24/08 6/5/09 EO
Consumer Products Amendments Approved amendments that add volatile organic compound (VOC) limits for seven additional categories and lower limits for twelve previously regulated categories.	6/26/08 5/5/09 EO
Zero emission vehicles Updated California's ZEV requirements to provide greater flexibility with respect to fuels, technologies, and simplifying compliance pathways. Amendments give manufacturers increased flexibility to comply with ZEV requirements by giving credit to plug-in hybrid electric vehicles and establishing additional ZEV categories in recognition of new developments in fuel cell vehicles and battery electric vehicles.	3/27/08 12/17/08 EO
Amendments to the Verification Procedure, Warranty, and In-Use Compliance Requirements for In-Use Strategies to Control Emissions from Diesel Engines Adds verification requirements for control technologies that only reduce NOx emissions, new reduction classifications for NOx reducing technologies, new testing requirements, and conditional extensions for verified technologies.	1/24/08 12/4/08 EO
Mandatory Report of Greenhouse Gas Emissions Approved a regulation that establishes detailed specifications for emissions calculations, reporting, and verification of GHG emission estimates from significant sources.	12/6/07 10/12/08 EO
Gaseous Pollutant Measurement Allowances for In-Use Heavy-Duty Diesel Compliance Measurement accuracy margins are to be determined through an ongoing comprehensive testing program performed by an independent contractor. Amendments include these measurement accuracy margins into the regulation.	12/6/07 10/14/08 EO
Ocean-Going Vessels While at Berth (aka Ship Hoteling) - Auxiliary Engine Cold Ironing and Clean Technology Approved a regulation that reduces emissions from auxiliary engines on ocean-going ships while at-berth.	12/6/07 10/16/08 EO
In-Use On-Road Diesel-Fueled Heavy-Duty Drayage Trucks at Ports and Rail Yard Facilities Approved a regulation that establishes emission standards for in-use, heavy-duty diesel-fueled vehicles that transport cargo to and from California's ports and intermodal rail facilities.	12/6/07 10/12/08 EO
Commercial Harbor Craft Approved a regulation that establishes in-use and new engine emission limits for both auxiliary and propulsion diesel engines on ferries, excursion vessels, tugboats, and towboats.	11/15/07 9/2/08 EO
Suggested Control Measure for Architectural Coatings Amendments Approved amendments to reduce the recommended VOC content of 19 categories of architectural coatings.	10/26/07
Aftermarket Catalytic Converter Requirements Approved amendments that establish more stringent emission performance and durability requirements for used and new aftermarket catalytic converters offered for sale in California.	10/25/07 2/21/08 NOD
Limiting Ozone Emissions from Indoor Air Cleaning Devices Approved ozone emission limit of 0.050 ppm for portable indoor air cleaning devices in response to requirements of AB 2276 (2006).	9/27/07 8/7/08 EO
Pesticide Commitment for Ventura County in 1994 SIP Approved substitution of excess ROG emission reductions from state motor vehicle program for 1994 SIP reduction commitment from pesticide application in Ventura County.	9/27/07 11/30/07 EO

Board Action	Hearing Date
In-Use Off-Road Diesel Equipment Approved a regulation that requires off-road diesel fleet owners to modernize their fleets and install exhaust retrofits.	7/26/07 4/4/08 EO
Emission Control and Environmental Performance Label Regulations Approved amendments to add a Global Index Label and modify the formal of the Smog Index Label on new cars.	6/21/07 5/2/08 EO
Vapor Recovery from Aboveground Storage Tanks Approved a regulation to establish new performance standards and specifications for the vapor recovery systems and components used with aboveground storage tanks.	6/21/07 5/2/08 EO
CaRFG Phase 3 amendments Approved amendments to mitigate the increases in evaporative emissions from on-road motor vehicles resulting from the addition of ethanol to gasoline.	6/14/07 4/25/08 EO 8/7/08 EO
Formaldehyde from Composite Wood Products Approved an ATCM to limit formaldehyde emissions from hardwood plywood, particleboard, and medium density fiberboard to the maximum amount feasible.	4/26/07 3/5/08 EO
Portable equipment registration program (PERP) and airborne toxic control measure for diesel-fueled portable engines Approved amendments to allow permitting of Tier 0 portable equipment engines used in emergency or low use duty and to extend permitting of certain Tier 1 and 2 "resident" engines to 1/1/10.	3/22/07 7/31/07 EO
Perchloroethylene Control Measure Amendments Approved amendments to the Perchloroethylene ATCM to prohibit new Perc dry cleaning machines beginning 2008 and phase out all Perc machines by 2023.	1/25/07 11/7/07 EO
Amendments to Emission Warranty Information Reporting & Recall Regulations Approved amendments that tighten the provisions for recalling vehicles for emissions-related failures, helping ensure that corrective action is taken to vehicles with defective emission control devices or systems.	12/7/06 3/22/07 10/17/07 EO
Voluntary accelerated vehicle retirement regulations Approved amendments that authorize the use of remote sensing to identify light-duty high emitters and that establish protocols for quantifying emissions reductions from high emitters proposed for retirement.	12/7/06
Emergency regulation for portable equipment registration program (PERP), airborne toxic control measures for portable and stationary diesel-fueled engines	12/7/06
Amendments to the Hexavalent Chromium ATCM Approved amendments that require use of best available control technology on all chrome plating and anodizing facilities.	12/7/06
Consumer Products Regulation Amendments Approved amendments that set lower emission limits in 15 product categories.	11/17/06 9/25/07 EO
Requirements for Stationary Diesel In-Use Agricultural Engines Approved amendments to the stationary diesel engine ATCM which set emissions standards for in-use diesel agricultural engines.	11/16/06 7/3/07 NOD
Ships - Onboard Incineration Approved amendments to cruise ship incineration ATCM to include all oceangoing ships of 300 gross registered tons or more.	11/16/06 9/11/07 EO
Zero Emission Bus Approved amendments postponing the 15 percent purchase requirement three years for transit agencies in the diesel path and one to two years for transit agencies in the alternative fuel path, in order to keep pace with developments in zero emission bus technology, and adding an Advanced Demonstration requirement to offset emission losses.	10/19/06 8/27/07 EO
Distributed generation certification Approved amendments improving the emissions durability and testing requirements, adding waste gas emission standards, and eliminating a redundant PM standard in the current 2007 emission standards.	10/19/06 5/17/07 NOD

Board Action	Hearing Date
Heavy-Duty Diesel In-Use Compliance Regulation Approved amendments to the heavy-duty diesel engine regulations and test procedures to create a new in-use compliance program conducted by engine manufacturers. The amendments would help ensure compliance with applicable certification standards throughout an engine's useful life.	9/28/06 7/19/07 NOD
Revisions to OBD II and the Emission Warranty Regulations Approved amendments to the OBD II regulation to provide for improved emission control monitoring including air-fuel cylinder imbalance monitoring, oxygen sensor monitoring, catalyst monitoring, permanent fault codes for gasoline vehicles and new thresholds for diesel vehicles.	9/28/06 8/9/07 EO
Off-Highway Recreational Vehicle Amendments Approved amendments to the Off-Highway Recreational Vehicle Regulations including harmonizing evaporative emission standards with federal regulations, expanding the definition of ATVs, modifying labeling requirements, and adjusting riding seasons.	7/20/06 6/1/07 EO
Portable Equipment Registration Program (PERP) Amendments Approved amendments to the Statewide Portable Equipment Registration program that include installation of hour meters on equipment, and revisions to recordkeeping, reporting, and fees.	6/22/06 11/13/06 NOD
Heavy Duty Vehicle Service Information Approved amendments to the Service Information Rule to require manufacturers to make available diagnostic equipment and information for sale to the aftermarket.	6/22/06 5/3/07 EO
LEV II technical amendments Approved amendments to evaporative emission test procedures, four-wheel drive dynamometer provisions, and vehicle label requirements.	6/22/06 9/27/06 NOD
Dry Cleaning ATCM Amendments Approved amendments to the Dry Cleaning ATCM to limit siting of new dry cleaners, phase out use of Perc at co-residential facilities, phase out higher emitting Perc sources at other facilities, and require enhanced ventilation at existing and new Perc facilities.	5/25/06
Forklifts and other Large Spark Ignition (LSI) Equipment Adopted a regulation to reduce emissions from forklifts and other off-road spark-ignition equipment by establishing more stringent standards for new equipment, and requiring retrofits or engine replacement on existing equipment. Adopts EPA's standards for 2007; adopts more stringent standards for 2010.	5/25/06 3/2/07 EO
Enhanced Vapor Recovery Amendments Approved amendments to the vapor recovery system regulation and adopted revised test procedures.	5/25/06
Diesel Retrofit Technology Verification Procedure Approved amendments to the Diesel Emission In-use Control Strategy Verification Procedure to substitute a 30% increase limit in NOx concentration for an 80% reduction requirement from PM retrofit devices.	3/23/06 12/21/06 NOD
Heavy duty vehicle smoke inspection program amendments Approved amendments to impose a fine on trucks not displaying a current compliance certification sticker.	1/26/06 12/4/06 EO
Ocean-going Ship Auxiliary Engine Fuel Approved a regulation to require ships to use cleaner marine gas oil or diesel to power auxiliary engines within 24 nautical miles of the California coast.	12/8/05 10/20/06 EO
Diesel Cargo Handling Equipment Approved a regulation to require new and in-use cargo handling equipment at ports and intermodal rail yards to reduce emissions by utilizing best available control technology.	12/8/05 6/2/06 EO
Public and Utility Diesel Truck Fleets Approved a regulation to reduce diesel particulate matter emissions from heavy duty diesel trucks in government and private utility fleets.	12/8/05 10/4/06 EO
Cruise ships – Onboard Incineration Adopted an Air Toxic Control Measure to prohibit cruise ships from conducting onboard incineration within three nautical miles of the California coast.	11/17/05 2/1/06 NOD
Inboard Marine Engine Rule Amendments Approved amendments to the 2001 regulation to include additional compliance options for manufacturers.	11/17/05 9/26/06 EO
Board Action	**Hearing Date**
Heavy-Duty Diesel Truck Idling Technology Approved a regulation to limit sleeper truck idling to 5 minutes. Allows alternate technologies to provide cab heating/cooling and power.	10/20/05 9/1/06 EO

Automotive Coating Suggested Control Measure Approved an SCM for automotive coatings for adoption by air districts. The measure will reduce the VOC content of 11 categories of surface protective coatings.	10/20/05
2007-09 Model-year heavy duty urban bus engines and the fleet rule for transit agencies Adopted amendments to align urban bus emission limits with on-road heavy duty truck emission limits and allow for the purchase of non- complying buses under the condition that bus turnover increase to offset NOx increases.	10/20/05 10/27/05 7/28/06 EO
Portable fuel containers (part 2 of 2) Approved amendments to revise spout and automatic shutoff design.	9/15/05 7/28/06 EO
Portable Fuel Containers (part 1 of 2) Approved amendments to include kerosene containers in the definition of portable fuel containers.	9/15/05 11/9/05 NOD
2007-09 Model-year heavy duty urban bus engines and the fleet rule for transit agencies Adopted amendments to require all transit agencies in SCAQMD to purchase only alternate fuel versions of new buses.	9/19/05 Superceded by 10/20/05
Reid vapor pressure limit emergency rule Approved amendments to relax Reid vapor pressure limit to accelerate fuel production for Hurricane Katrina victims.	9/8/05 Operative for September and October 2005 only
Heavy-Duty Truck OBD Approved a regulation to require on-board diagnostic (OBD) systems for new gas and diesel trucks, similar to the systems on passenger cars.	7/21/05 12/28/05 EO
Definition of Large Confined Animal Facility Adopted a regulation to define the size of a large CAF for the purposes of air quality permitting and reduction of ROG emissions to the extent feasible.	6/23/05 4/13/06 EO
ATCM for stationary compression ignition engines Approved emergency amendments (3/17/05) and permanent amendments (5/26/05) to relax the diesel PM emission limits on new stationary diesel engines to current off-road engine standards to respond to the lack of availability of engines meeting the original ATCM standard.	3/17/05 5/26/05 7/29/05 EO
Transit Fleet Rule Approved amendments to add emission limits for non-urban bus transit agency vehicles, require lower bus and truck fleet-average NOx and PM emission limits, and clarify emission limits for CO, NMHC, and formaldehyde.	2/24/05 10/19/05 NOD
Thermal Spraying ATCM Approved a regulation to reduce emissions of hexavalent chromium and nickel from thermal spraying operations.	12/9/04 7/20/05 EO
Tier 4 Standards for Small Off-Road Diesel Engines (SORE) Approved new emission standards for off-road diesel engines to be phased in between 2008 and 2015.	12/9/04 10/21/05 EO
Emergency Regulatory Amendment Delaying the January 1, 2005 Implementation Date for the Diesel Fuel Lubricity Standard Adopted an emergency regulation delaying the lubricity standard compliance deadline by five months to respond to fuel pipeline contamination problems.	11/24/04 12/10/04 EO
Enhanced vapor recovery compliance extension Approved amendments to the EVR regulation to extend the compliance date for onboard refueling vapor recovery compatibility to the date of EVR compliance.	11/18/04 2/11/05 EO
CaRFG Phase 3 amendments Approved amendments correcting errors and streamlining requirements for compliance and enforcement of CaRFG Phase 3 regulations adopted in 1999.	11/18/04
Clean diesel fuel for harborcraft and intrastate locomotives Approved a regulation that required harborcraft and locomotives operating solely within California to use clean diesel fuel.	11/18/04 3/16/05 EO

Board Action	Hearing Date
Nonvehicular Source, Consumer Product, and Architectural Coating Fee Regulation Amendment Approved amendments to fee regulations to collect supplemental fees when authorized by the Legislature.	11/18/04
Greenhouse gas limits for motor vehicles Approved a regulation that sets the first ever greenhouse gas emission standards on light and medium duty vehicles starting with the 2009 model year.	9/24/04 8/4/05 EO
Gasoline vapor recovery system equipment defects list Approved the addition of defects to the VRED list for use by compliance inspectors.	8/24/04 6/22/05 EO
Unihose gasoline vapor recovery systems Approved an emergency regulation and an amendment to delay the compliance date for unihose installation to the date of dispenser replacement.	7/22/04 11/24/04 EO
General Idling Limits for Diesel Trucks Approved a regulation that limits idling of heavy-duty diesel trucks operating in California to five minutes, with exceptions for sleeper cabs.	7/22/04
Consumer Products Approved a regulation to reduce ROG emissions from 15 consumer products categories, prohibit the use of 3 toxic compounds in consumer products, ban the use of PDCB in certain products, allow for the use of Alternative Control Plans, and revise Test Method 310.	6/24/04 5/6/05 EO
Urban bus engines/fleet rule for transit agencies Approved amendments to allow for the purchase of hybrid diesel buses and revise the zero emission bus demonstration and purchase timelines.	6/24/04
Engine Manufacturer Diagnostics Approved a regulation that would require model year 2007 and later heavy duty truck engines to be equipped with engine diagnostic systems to detect malfunctions of the emission control system.	5/20/04
Chip Reflash Approved a voluntary program and a backstop regulation to reduce heavy duty truck NOx emissions through the installation of new software in the engine's electronic control module.	3/25/04 3/21/05 EO
Portable equipment registration program (PERP) Approved amendments to allow uncertified engines to be registered until December 31, 2005, to increase fees, and to modify administrative requirements.	2/26/04 1/7/05 EO 6/21/05 EO
Portable Diesel Engine ATCM Adopted a regulation to reduce diesel PM emissions from portable engines through a series of emission standards that increase in stringency through 2020.	2/26/04 1/4/05 EO
California motor vehicle service information rule Adopted amendments to allow for the purchase of heavy duty engine emission-related service information and diagnostic tools by independent service facilities and aftermarket parts manufacturers.	1/22/04 5/20/04
Transportation Refrigeration Unit ATCM Adopted a regulation to reduce diesel PM emissions from transport refrigeration units by establishing emission standards and facility reporting requirements to streamline inspections.	12/11/03 2/26/04 11/10/04 EO
Diesel engine verification procedures Approved amendments that reduced warranty coverage to the engine only, delayed the NOx reduction compliance date to 2007, added requirements for proof-of-concept testing for new technology, and harmonized durability requirements with those of U.S. EPA.	12/11/03 2/26/04 10/17/04
Chip Reflash Approved a voluntary program and a backstop regulation to reduce heavy duty truck NOx emissions through the installation of new software in the engine’s electronic control module.	12/11/03 3/27/04 3/21/05 EO
Revised tables of maximum incremental reactivity values Approved the addition of 102 more chemicals with associated maximum incremental reactivity values to existing regulation allowing these chemicals to be used in aerosol coating formulations.	12/3/03

Board Action	Hearing Date
Stationary Diesel Engines ATCM Adopted a regulation to reduce diesel PM emissions from stationary diesel engines through the use of clean fuel, lower emission standards, operational practices.	11/20/03 12/11/03 2/26/2004 9/27/04 EO
Solid waste collection vehicles Adopted a regulation to reduce toxic diesel particulate emissions from solid waste collection vehicles by over 80 percent by 2010. This measure is part of ARB's plan to reduce the risk from a wide range of diesel engines throughout California.	9/25/03 5/17/04 EO
Small off-road engines (SORE) Adopted more stringent emission standards for the engines used in lawn and garden and industrial equipment, such as string trimmers, leaf blowers, walk-behind lawn mowers, generators, and lawn tractors.	9/25/03 7/26/04 EO
Off-highway recreational vehicles Changes to riding season restrictions.	7/24/03
Clean diesel fuel Adopted a regulation to reduce sulfur levels and set a minimum lubricity standard in diesel fuel used in vehicles and off-road equipment in California, beginning in 2006.	7/24/03 5/28/04 EO
Ozone Transport Mitigation Amendments Adopted amendments to require upwind districts to (1) have the same no-net-increase permitting thresholds as downwind districts, and (2) Adopt "all feasible measures."	5/22/03 10/2/03 NOD
Zero emission vehicles Updated California's ZEV requirements to support the fuel cell car development and expand sales of advanced technology partial ZEVs (like gasoline-electric hybrids) in the near-term, while retaining a role for battery electric vehicles.	3/27/03 12/19/03 EO
Heavy duty gasoline truck standards Aligned its existing rules with new, lower federal emission standards for gasoline-powered heavy-duty vehicles starting in 2008.	12/12/02 9/23/03 EO
Low emission vehicles II Minor administrative changes.	12/12/02 9/24/03 EO
Gasoline vapor recovery systems test procedures Approved amendments to add advanced vapor recovery technology certification and testing standards.	12/12/02 7/1/03 EO 10/21/03 EO
CaRFG Phase 3 amendments Approved amendments to allow for small residual levels of MTBE in gasoline while MTBE is being phased out and replaced by ethanol.	12/12/02 3/20/03 EO
School bus Idling Adopted a measure requiring school bus drivers to turn off the bus or vehicle engine upon arriving at a school and restart it no more than 30 seconds before departure in order to limit children's exposure to toxic diesel particulate exhaust.	12/12/02 5/15/03 EO
California Interim Certification Procedures for 2004 and Subsequent Model Year Hybrid-Electric Vehicles in the Urban Transit Bus and Heavy-Duty Vehicle Classes Regulation Amendment Adopted amendments to allow diesel-path transit agencies to purchase alternate fuel buses with higher NOx limits, establish certification procedures for hybrid buses, and require lower fleet-average PM emission limits.	10/24/02 9/2/03 EO
CaRFG Phase 3 amendments Approved amendments delaying removal of MTBE from gasoline by one year to 12/31/03.	7/25/02 11/8/02 EO
Diesel retrofit verification procedures, warranty, and in-use compliance requirements Adopted regulations to specify test procedures, warranty, and in-use compliance of diesel engine PM retrofit control devices.	5/16/02 3/28/03 EO
On-board diagnostics for cars Adopted changes to the On-Board Diagnostic Systems (OBD II) regulation to improve the effectiveness of OBD II systems in detecting motor vehicle emission-related problems.	4/25/02 3/7/03 EO

Board Action	Hearing Date
Voluntary accelerated light duty vehicle retirement regulations Establishes standards for a voluntary accelerated retirement program.	2/21/02 11/18/02 EO
Residential burning Adopted a measure to reduce emissions of toxic air contaminants from outdoor residential waste burning by eliminating the use of burn barrels and the outdoor burning of residential waste materials other than natural vegetation.	2/21/02 12/18/02 EO
California motor vehicle service information rule Adopted regulations to require light- and medium-duty vehicle manufacturers to offer for sale emission-related service information and diagnostic tools to independent service facilities and aftermarket parts manufacturers.	12/13/01 7/31/02 EO
Vapor recovery regulation amendments Adopted amendments to expand the list of specified defects requiring equipment to be removed from service.	11/15/01 9/27/02 EO
Distributed generation guidelines and regulations Adopted regulations requiring the permitting by ARB of distributed generation sources that are exempt from air district permitting and approved guidelines for use by air districts in permitting non-exempt units.	11/15/01 7/23/02 EO
Low emission vehicle regulations (LEV II) Approved amendments to apply PM emission limits to all new gasoline vehicles, extend gasoline PZEV emission limits to all fuel types, and streamline the manufacturer certification process.	11/15/01 8/6/02 EO
Gasoline vapor recovery systems test methods and compliance procedures Adopted amendments to add test methods for new technology components, streamline test methods for liquid removal equipment, and***.	10/25/01 7/9/02 EO
Heavy-duty diesel trucks Adopted amendments to emissions standards to harmonize with EPA regulations for 2007 and subsequent model year new heavy-duty diesel engines.	10/25/01
Automotive coatings Adopted Air Toxic Control Measure which prohibits the sale and use in California of automotive coatings that contain hexavalent chromium or cadmium.	9/20/01 9/2/02 EO
Inboard and sterndrive marine engines Lower emission standards for 2003 and subsequent model year inboard and sterndrive gasoline-powered engines in recreational marine vessels.	7/26/01 6/6/02 EO
Asbestos from construction, grading, quarrying, and surface mining Adopted an Airborne Toxic Control Measure for construction, grading, quarrying, and surface mining operations requiring dust mitigation for construction and grading operations, road construction and maintenance activities, and quarries and surface mines to minimize emissions of asbestos-laden dust.	7/26/01 6/7/02 EO
Zero emission vehicle infrastructure and standardization of electric vehicle charging equipment Adopted amendments to the ZEV regulation to alter the method of quantifying production volumes at joint-owned facilities and to add specifications for standardized charging equipment.	6/28/01 5/10/02 EO
Pollutant transport designation Adopted amendments to add two transport couples to the list of air basins in which upwind areas are required to adopt permitting thresholds no less stringent than those adopted in downwind areas.	4/26/01
Zero emission vehicle regulation amendments Adopted amendments to reduce the numbers of ZEVs required in future years, add a PZEV category and grant partial ZEV credit, modify the ZEV range credit, allow hybrid-electric vehicles partial ZEV credit, grant ZEV credit to advanced technology vehicles, and grant partial ZEV credit for several other minor new programs.	1/25/01 12/7/01 EO 4/12/02 EO
Heavy duty diesel engines supplemental test procedures Approved amendments to extend "Not-To-Exceed" and EURO III supplemental test procedure requirements through 2007 when federal requirements will include these tests.	12/7/00
Board Action	**Hearing Date**
Light and medium duty low emission vehicle alignment with federal standards Approved amendments that require light and medium duty vehicles sold in California to meet the more restrictive of state or federal emission standards.	12/7/00 12/27/00 EO

Exhaust emission standards for heavy duty gas engines Adopted amendments that establish 2005 emission limits for heavy duty gas engines that are equivalent to federal limits.	12/7/00 12/27/00 EO
CaRFG Phase 3 amendments Approved amendments to regulate the replacement of MTBE in gasoline with ethanol.	11/16/00 4/25/01 EO
CaRFG Phase 3 test methods Approved amendments to gasoline test procedures to quantify the olefin content and gasoline distillation temperatures.	11/16/00 7/11/01 EO 8/28/01 EO
Antiperspirant and deodorant regulations Adopted amendments to relax a 0% VOC limit to 40% VOC limit for aerosol antiperspirants.	10/26/00
Diesel risk reduction plan Adopted plan to reduce toxic particulate from diesel engines through retrofits on existing engines, tighter standards for new engines, and cleaner diesel fuel.	9/28/00
Conditional rice straw burning regulations Adopted regulations to limit rice straw burning to fields with demonstrated disease rates reducing production by more than 5 percent.	9/28/00
Asbestos from unpaved roads Tightened an existing Air Toxic Control Measure to prohibit the use of rock containing more than 0.25% asbestos on unsurfaced roads.	7/20/00
Aerosol Coatings Approved amendments to replace mass-based VOC limits with reactivity-based limits, add a table of Maximum Incremental Reactivity values, add limits for polyolefin adhesion promoters, prohibit use of certain toxic solvents, and make other minor changes.	6/22/00 5/1/01 EO
Consumer products aerosol adhesives Adopted amendments to delete a 25% VOC limit by 2002, add new VOC limits for six categories of adhesives, prohibit the use of toxic solvents, and add new labeling and reporting requirements.	5/25/00 3/14/01 EO
Automotive care products Approved an Air Toxic Control Measure to eliminate use of perchloroethylene, methylene chloride, and trichloroethylene in automotive products such as brake cleaners and degreasers.	4/27/00 2/28/01 EO
Enhanced vapor recovery emergency regulation Adopted a four-year term for equipment certifications.	5/22/01 EO
Enhanced vapor recovery Adopted amendments to require the addition of components to reduce spills and leakage, adapt to onboard vapor recovery systems, and continuously monitor system operation and report equipment leaks immediately.	3/23/00 7/25/01 EO
Agricultural burning smoke management Adopted amendments to add marginal burn day designations, require day-specific burn authorizations by districts, and smoke management plans for larger prescribed burn projects.	3/23/00 1/22/01 EO
Urban transit buses Adopted a public transit bus fleet rule and emissions standards for new urban buses that mandates a lower fleet-average NOx emission limit, PM retrofits, lower sulfur fuel use, and purchase of specified percentages of zero emission buses in future years.	1/27/00 2/24/00 11/22/00 EO 5/29/01 EO
Small Off-Road (diesel) Equipment (SORE) Adopted amendments to conform with new federal requirements for lower and engine power-specific emission limits, and for the averaging, banking, and trading of emissions among SORE manufacturers.	1/28/00

Board Action	Hearing Date
CaRFG Phase 3 MTBE phase out Adopted regulations to enable refiners to produce gasoline without MTBE while preserving the emissions benefits of Phase 2 cleaner burning gasoline.	12/9/99 6/16/00 EO
Consumer products – mid-term measures II Adopted a regulation which adds emission limits for 2 new categories and tightens emission limits for 15 categories of consumer products.	10/28/99
Portable fuel cans Adopted a regulation requiring that new portable fuel containers, used to refuel lawn and garden equipment, motorcycles, and watercraft, be spill-proof beginning in 2001.	9/23/99 7/6/00 EO
Clean fuels at service stations Adopted amendments rescinding requirements applicable to SCAB in 1994-1995, modifying the formula for triggering requirements, and allowing the Executive Officer to make adjustments to the numbers of service stations required to provide clean fuels.	7/22/99
Gasoline vapor recovery Adopted amendments to certification and test methods.	6/24/99
Reformulated gasoline oxygenate Adopted amendments rescinding the requirement for wintertime oxygenate in gasoline sold in the Lake Tahoe Air Basin and requiring the statewide labeling of pumps dispensing gasoline containing MTBE.	6/24/99
Marine pleasurecraft Adopted regulations to control emissions from spark-ignition marine engines, specifically, outboard marine engines and personal watercraft.	12/11/98 2/17/00 EO 6/14/00 EO
Voluntary accelerated light duty vehicle retirement Adopted regulation setting standards for voluntary accelerated retirement program.	12/10/98 10/22/99 EO
Off-highway recreational vehicles and engines Approved amendments to allow non-complying vehicles to operate in certain seasons and in certain ORV-designated areas.	12/10/98 10/22/99 EO
On-road motorcycles Amended on-road motorcycle regulations, to lower the tailpipe emission standards for ROG and NOx.	12/10/98
Portable equipment registration program (PERP) Approved amendments to exclude non-dredging equipment operating in OCS areas and equipment emitting hazardous pollutants, include NSPS Part OOO rock crushers, require SCR emission limits and onshore emission offsets from dredging equipment operating in OCS areas, set catalyst emission limits for gasoline engines, and relieve certain retrofitted engines from periodic source testing.	12/10/98
Liquid petroleum gas motor fuel specifications Approved amendment rescinding 5% propene limit and extending 10% limit indefinitely.	12/11/98
Reformulated gasoline Approved amendments to rescind the RVP exemption for fuel with 10% ethanol and allow for oxygen contents up to 3.7% if the Predictive Model weighted emissions to not exceed original standards.	12/11/98
Consumer products Adopted amendments to add new VOC test methods, to modify Method 310 to quantify low vapor pressure VOC (LVP-VOC) constituents, and to exempt LVP-VOC from VOC content limits	11/19/98
Consumer products Approved amendments to extend the 1999 VOC compliance deadline for several aerosol coatings, antiperspirants and deodorants, and other consumer products categories to 2002, to exempt methyl acetate from the VOC definition, and make other minor changes.	11/19/98
Low-emission vehicle program (LEV II) Adopted regulations adding exhaust emission standards for most sport utility vehicles, pick-up trucks and mini-vans, lowering tailpipe standards for cars, further reducing evaporative emission standards, and providing additional means for generating zero-emission vehicle credits.	11/5/98 9/17/99 EO
Board Action	**Hearing Date**
Off-road engine aftermarket parts Approved implementation of a new program to test and certify aftermarket parts in gasoline and diesel, light-duty through heavy duty, engines used in off-road vehicles and equipment.	11/19/98 10/1/99 EO 7/18/00 EO

Off-road spark ignition engines Adopted new emission standards for small and large spark ignition engines for off-road equipment, a new engine certification program, an in-use compliance testing program, and a three-year phase-in for large LSI.	10/22/98
Gasoline deposit control additives Adopted amendments to decertify pre-RFG additives, tighten the inlet valve deposit limits, add a combustion chamber deposit limit, and modify the test procedures to align with the characteristics of reformulated gasoline formulations.	9/24/98 4/5/99 EO
Stationary source test methods Adopted amendments to stationary source test methods to align better with federal methods.	8/27/98 7/2/99 EO
Locomotive MOA for South Coast Memorandum of agreement (MOA) signed by ARB, U.S. EPA and major railroads to concentrate cleaner locomotives in the South Coast by 2010 and fulfill 1994 ozone SIP commitment.	7/2/98
Gasoline vapor recovery Adopted amendments to certification and test methods to add methods for onboard refueling vapor recovery, airport refuelers, and underground tank interconnections, and make minor changes to existing methods.	5/21/98 8/27/98
Reformulated gasoline Approved amendments to rescind the wintertime oxygenate requirement, allow for sulfur content averaging, and make other minor technical amendments.	8/27/98
Ethylene oxide sterilizers Adopted amendments to the ATCM to streamline source testing requirements, add EtO limits in water effluent from control devices, and make other minor changes.	5/21/98
Chrome platers Adopted amendments to ATCM to harmonize with requirements of federal NESHAP standards for chrome plating and chromic acid anodizing facilities.	5/21/98
On-road heavy-duty vehicles Approved amendments to align on-road heavy duty vehicle engine emission standards with EPA's 2004 standards and align certification, testing, maintenance, and durability requirements with those of U.S. EPA.	4/23/98 2/26/99 EO
Small off-road engines (SORE) Approved amendments to grant a one-year delay in implementation, relaxation of emissions standards for non-handheld engines, emissions durability requirements, averaging/banking/trading, harmonization with the federal diesel engine regulation, and modifications to the production line testing requirements.	3/26/98
Heavy duty vehicle smoke inspection program Adopted amendments to require annual smoke testing, set opacity limits, and exempt new vehicles from testing for the first four years.	12/11/97 3/2/98 EO
Consumer products (hairspray credit program) Adopted standards for the granting of tradable emission reduction credits achieved by sales of hairspray products having VOC contents less than required limits.	11/13/97
Light-duty vehicle off-cycle emissions Adopted standards to control excess emissions from aggressive driving and air conditioner use in light duty vehicles and added two light duty vehicle test methods for certification of new vehicles under these standards.	7/24/97 3/19/98 EO
Consumer products Adopted amendments to add VOC limits to 18 categories of consumer products used in residential and industrial cleaning, automobile maintenance, and commercial poisons.	7/24/97
Enhanced evaporative emissions standards Adopted amendments extending the compliance date for ultra-small volume vehicle manufacturers by one year.	5/22/97
Board Action	**Hearing Date**
Emission reduction credit program Adopted standards for District establishment of ERC programs including certification, banking, use limitation, and reporting requirements.	5/22/97
Lead as a toxic air contaminant Adopted an amendment to designate inorganic lead as a toxic air contaminant.	4/24/97

Consumer products (hair spray) Adopted amendments to (1) delay a January 1, 1998, compliance deadline to June 1, 1999, (2) require progress plans from manufacturers, and (3) authorize the Executive Officer to require VOC mitigation when granting variances from the June 1, 1999 deadline.	3/27/97
Portable engine registration program (PERP) Adopted standards for (1) the permitting of portable engines by ARB and (2) District recognition and enforcement of permits.	3/27/97
Liquefied petroleum gas Adopted amendments to extend the compliance deadline from January 1, 1997, to January 1, 1999, for the 5% propene limit in liquefied petroleum gas used in motor vehicles.	3/27/97
Onboard diagnostics, phase II Adopted amendments to extend the phase-in of enhanced catalyst monitoring, modify misfire detection requirements, add PVC system and thermostat monitoring requirements, and require manufacturers to sell diagnostic tools and service information to repair shops.	12/12/96
Consumer products Adopted amendments to delay 25% VOC compliance date for aerosol adhesives, clarify portions of the regulation, exempt perchloroethylene from VOC definition, extend the sell-through time to three years, and add perchloroethylene reporting requirements.	11/21/96
Consumer products (test method) Adopted an amendment to add Method 310 for the testing of VOC content in consumer products.	11/21/96
Pollutant transport designation Adopted amendments to modify transport couples from the Broader Sacramento area and add couples to the newly formed Mojave Desert and Salton Sea Air Basins.	11/21/96
Diesel fuel certification test methods Approved amendments specifying the test methods used for quantifying the constituents of diesel fuel.	10/24/96 6/4/97 EO
Wintertime requirements for utility engines & off-highway vehicles Optional hydrocarbon and NOx standards for snow throwers and ice augers, raising CO standard for specialty vehicles under 25hp.	9/26/96
Large off-road diesel Statement of Principles National agreement between ARB, U.S. EPA, and engine manufacturers to reduce emissions from heavy-duty off-road diesel equipment four years earlier than expected in the 1994 SIP for ozone.	9/13/96
Regulatory improvement initiative Rescinded two regulations relating to fuel testing in response to Executive Order W-127-95.	5/30/96
Zero emission vehicles Adopted amendments to eliminate zero emission vehicle quotas between 1998 and 2002, and approved MOUs with seven automobile manufacturers to accelerate release of lower emission "49 state" vehicles.	3/28/96 7/24/96 EO
CaRFG variance requirements Approved amendments to add a per gallon fee on non-compliant gasoline covered by a variance and to made administrative changes in variance processing and extension.	1/25/96 2/5/96 EO 4/2/96 EO
Utility and lawn and garden equipment engines Adopted an amendment to relax the CO standard from 300 to 350 ppm for Class I and II utility engines.	1/25/96
National security exemption of military tactical vehicles Such vehicles would not be required to adhere to exhaust emission standards.	12/14/95

Board Action	Hearing Date
CaRFG regulation amendments Approved amendments to allow for downstream addition of oxygenates and expansion of compliance options for gasoline formulation.	12/14/95
Required additives in gasoline (deposit control additives) Terms, definitions, reporting requirements, and test procedures for compliance are to be clarified.	11/16/95
CaRFG test method amendments Approved amendments to designate new test methods for benzene, aromatic hydrocarbon, olefin, and sulfur content of gasoline.	10/26/95
Motor vehicle inspection and maintenance program Handled by BAR.	10/19/95 by BAR
Antiperspirants and deodorants, consumer products, and aerosol coating products Ethanol exemption for all products, modifications to aerosol special requirements, modifications for regulatory language consistency, modifications to VOC definition.	9/28/95
Low emission vehicle (LEV III) standards Reactivity adjustment factors, introduction of medium-duty ULEVs, window labels, and certification requirements and test procedures for LEVs.	9/28/95
Medium- and heavy-duty gasoline trucks Expedited introduction of ultra-low emission medium-duty vehicles and lower NOx emission standards for heavy-duty gasoline trucks to fulfill a 1994 ozone SIP commitment.	9/1/95
Retrofit emission standards: all vehicle classes to be included in the alternate durability test plan, kit manufacturers to be allowed two years to validate deterioration factors under the test plan, update retrofit procedures allowing manufacturers to disable specific OBDs if justified by law.	7/27/95
Gasoline vapor recovery systems Adopts revised certification and test procedures.	6/29/95
Onboard refueling vapor recovery standards 1998 and subsequent MY engine cars, LD trucks, and MD trucks less than 8500 GVWR.	6/29/1995 4/24/96 EO
Heavy duty vehicle exhaust emission standards for NOx Amendments to standards and test procedures for 1985 and subsequent MY HD engines, amendments to emission control labels, amendments to Useful Life definition and HD engines and in-use vehicle recalls.	6/29/95
Aerosol coatings regulation Adopted regulation to meet California Clean Air Act requirements and a 1994 ozone SIP commitment.	3/23/95
Periodic smoke inspection program Delays start of PSIP from 1995 to 1996.	12/8/94
Onboard diagnostics phase II Amendments to clarify regulation language, ensure maximum effectiveness, and address manufacturer concerns regarding implementation.	12/8/94
Alternative control plan (ACP) for consumer products A voluntary, market-based VOC emissions cap upon a grouping of consumer products, flexible by manufacturer that will minimize overall costs of emission reduction methods and programs.	9/22/94
Diesel fuel certification: new specifications for diesel engine certification fuel, amended oxygen specification for CNG certification fuel, and amended commercial motor vehicle liquefied petroleum gas regulations.	9/22/94
Utility and lawn and garden equipment (UGLE) engines Modification to emission test procedures, ECLs, defects warranty, quality-audit testing, and new engine compliance testing.	7/28/94
Evaporative emissions standards and test procedures Adopted evaporative emissions standards for medium-duty vehicles.	2/10/94

Board Action	Hearing Date
Off-road recreational vehicles Adopted emission control regulations for off-road motorcycles, all-terrain vehicles, go-karts, golf carts, and specialty vehicles.	1/1/94
Perchloroethylene from dry cleaners Adopted measure to control perchloroethylene emissions from dry cleaning operations.	10/1/93
Wintertime oxygenate program Amendments to the control time period for San Luis Obispo County, exemption for small retailers bordering Nevada, flexibility in gasoline delivery time, calibration of ethanol blending equipment, gasoline oxygen content test method.	9/9/93
Onboard diagnostic phase II	7/9/93
Urban transit buses Amended regulation to tighten state NOx and particulate matter (PM) standards for urban transit buses beyond federal standards beginning in 1996.	6/10/93
1-year implementation delay in emission standards for utility engines	4/8/93
Non-ferrous metal melting Adopted Air Toxic Control Measure for emissions of cadmium, arsenic, and nickel from non-ferrous metal melting operations.	1/1/93
Certifications requirements for low emission passenger cars, light-duty trucks & medium duty vehicles	1/14/93
Airborne toxic control measure for emissions of toxic metals from non-ferrous metal melting	12/10/92
Periodic self-inspection program Implemented state law establishing a periodic smoke self-inspection program for fleets operating heavy-duty diesel-powered vehicles.	12/10/92
Notice of general public interest for consumer products	11/30/92
Substitute fuel or clean fuel incorporated test procedures	11/12/92
New vehicle testing using CaRFG Phase 2 gasoline Approved amendments to require the use of CaRFG Phase 2 gasoline in the certification of exhaust emissions in new vehicle testing.	8/13/92
Standards and test procedures for alternative fuel retrofit systems	5/14/92
Alternative motor vehicle fuel certification fuel specification	3/12/92
Heavy-duty off-road diesel engines Adopted the first exhaust emission standards and test procedures for heavy-duty off-road diesel engines beginning in 1996.	1/9/92
Consumer Products - Tier II Adopted Tier II of regulations to reduce emissions from consumer products.	1/9/92
Wintertime oxygen content of gasoline Adopted regulation requiring the addition of oxygenates to gasoline during winter to satisfy federal Clean Air Act mandates for CO non-attainment areas.	12/1/91
CaRFG Phase 2 Adopted CaRFG phase 2 specifications including lowering vapor pressure, reducing the sulfur, olefin, aromatic, and benzene content, and requiring the year-round addition of oxygenates to achieve reductions in ROG, NOx, CO, oxides of sulfur (SOx) and toxics.	11/1/91
Low emissions vehicles amendments revising reactivity adjust factor (RAF) provisions and adopting a RAF for M85 transitional low emission vehicles	11/14/91
Onboard diagnostic, phase II	11/12/91
Onboard diagnostics for light-duty trucks and light & medium-duty motor vehicles	9/12/91
Utility and lawn & garden equipment Adopted first off-road mobile source controls under the California Clean Air Act regulating utility, lawn and garden equipment.	12/1/90
Control for abrasive blasting	11/8/90

Board Action	Hearing Date
Roadside smoke inspections of heavy-duty vehicles Adopted regulations implementing state law requiring a roadside smoke inspection program for heavy-duty vehicles.	11/8/90
Consumer Products Tier I Adopted Tier I of standards to reduce emissions from consumer products.	10/11/90
CaRFG Phase I Adopted CaRFG Phase I reformulated gasoline regulations to phase-out leaded gasoline, reduce vapor pressure, and require deposit control additives.	9/1/90
Low-emission vehicle (LEV) and clean fuels Adopted the landmark LEV/clean fuel regulations which called for the gradual introduction of cleaner cars in California. The regulations also provided a mechanism to ensure the availability of alternative fuels when a certain number of alternative fuel vehicles are sold.	9/1/90
Evaporative emissions from vehicles Modified test procedure to include high temperatures (up to 105 F) and ensure that evaporative emission control systems function properly on hot days.	8/9/90
Dioxins from medical waste incinerators Adopted Airborne Toxic Control Measure to reduce dioxin emissions from medical waste incinerators.	7/1/90
CA Clean Air Act guidance for permitting Approved California Clean Air Act permitting program guidance for new and modified stationary sources in non-attainment areas.	7/1/90
Consumer products BAAQMD	6/14/90
Medium duty vehicle emission standards Adopted three new categories of low emission MDVs, required minimum percentages of production, and established production credit and trading.	6/14/90
Medium-duty vehicles Amended test procedures for medium-duty vehicles to require whole-vehicle testing instead of engine testing. This modification allowed enforcement of medium-duty vehicle standards through testing and recall.	6/14/90
Ethylene oxide sterilizers Adopted Airborne Toxic Control Measure to reduce ethylene oxide emissions from sterilizers and aerators.	5/10/90
Asbestos in serpentine rock Adopted Airborne Toxic Control Measure for asbestos-containing serpentine rock in surfacing applications.	4/1/90
Certification procedure for aftermarket parts	2/8/90
Antiperspirants and deodorants Adopted first consumer products regulation, setting standards for antiperspirants and deodorants.	11/1/89
Residential woodstoves Approved suggested control measure for the control of emissions from residential wood combustion.	11/1/89
On-Board Diagnostic Systems II Adopted regulations to implement the second phase of on-board diagnostic requirements which alert drivers of cars, light-trucks and medium-duty vehicles when the emission control system is not functioning properly.	9/1/89
Cars and light-duty trucks Adopted regulations to reduce ROG and CO emissions from cars and light trucks by 35 percent.	6/1/89
Architectural coatings Approved a suggested control measure to reduce ROG emissions from architectural coatings.	5/1/89
Chrome from cooling towers Adopted Airborne Toxic Control Measure to reduce hexavalent chromium emissions from cooling towers.	3/1/89

Board Action	Hearing Date
Reformulated Diesel Fuel Adopted regulations requiring the use of clean diesel fuel with lower sulfur and aromatic hydrocarbons beginning in 1993.	11/1/88
Vehicle Recall Adopted regulations implementing a recall program which requires auto manufacturers to recall and fix vehicles with inadequate emission control systems (Vehicles are identified through in-use testing conducted by the ARB).	9/1/88
Suggested control measure for oil sumps Approved a suggested control measure to reduce emissions from sumps used in oil production operations.	8/1/88
Chrome platers Adopted Airborne Toxic Control Measure to reduce emissions of hexavalent chromium emissions from chrome plating and chromic acid anodizing facilities.	2/1/88
Suggested control measure for boilers Approved suggested control measure to reduce NOx emissions from industrial, institutional, and commercial boilers, steam generators and process heaters.	9/1/87
Benzene from service stations Adopted Airborne Toxic Control Measure to reduce benzene emissions from retail gasoline service stations (Also known as Phase II vapor recovery).	7/1/87
Agricultural burning guidelines Amended existing guidelines to add provisions addressing wildland vegetation management.	11/1/86
Heavy-duty vehicle certification Amended certification of heavy-duty diesel and gasoline-powered engines and vehicles to align with federal standards.	4/1/86
Cars and light-duty trucks Adopted regulations reducing NOx emissions from passenger cars and light-duty trucks by 40 percent.	4/1/86
Sulfur in diesel fuel Removed exemption for small volume diesel fuel refiners.	6/1/85
On-Board Diagnostics I Adopted regulations requiring the use of on-board diagnostic systems on gasoline-powered vehicles to alert the driver when the emission control system is not functioning properly.	4/1/85
Suggested control measure for wood coatings Approved a suggested control measure to reduce emissions from wood furniture and cabinet coating operations.	3/1/85
Suggested control measure for resin manufacturing Approved a suggested control measure to reduce ROG emissions from resin manufacturing.	1/1/85

Appendix C

CARB Analyses of Key Mobile Source Regulations

& Programs Providing Emission Reductions

CARB Analyses of Key Mobile Source Regulations & Programs
Providing Emission Reductions

I. INTRODUCTION

Given the severity of California's air quality challenges and the need for ongoing emission reductions, the Air Resources Board (ARB) has implemented the most stringent mobile source emissions control program in the nation. ARB's comprehensive program relies on four fundamental approaches:

- stringent emissions standards that minimize emissions from new vehicles and equipment;
- in-use programs that target the existing fleet and require the use of the cleanest vehicles and emissions control technologies;
- cleaner fuels that minimize emissions during combustion; and,
- incentive programs that remove older, dirtier vehicles and equipment and pay for early adoption of the cleanest available technologies.

This multi-faceted approach has spurred the development of increasingly cleaner technologies and fuels and achieved significant emission reductions across all mobile source sectors that go far beyond national programs or programs in other states. These efforts extend back to the first mobile source regulations adopted in the 1960s, and pre-date the federal Clean Air Act Amendments (Act) of 1970, which established the basic national framework for controlling air pollution. In recognition of the pioneering nature of ARB's efforts, the Act provides California unique authority to regulate mobile sources more stringently than the federal government by providing a waiver of preemption for its new vehicle emission standards under Section 209(b). This waiver provision preserves a pivotal role for California in the control of emissions from new motor vehicles, recognizing that California serves as a laboratory for setting motor vehicle emission standards. Since then, the ARB has consistently sought and obtained waivers and authorizations for its new motor vehicle regulations. ARB's history of progressively strengthening standards as technology advances, coupled with the waiver process requirements, ensures that California's regulations remain the most stringent in the nation. A list of regulatory actions ARB has taken since 1985 is provided at the end of this analysis to highlight the scope of ARB's actions to reduce mobile source emissions.

Recently, ARB adopted numerous regulations aimed at reducing exposure to diesel particulate matter and oxides of nitrogen, from freight transport sources like heavy duty diesel trucks, transportation sources like passenger cars and buses, and off-road sources like large construction equipment. Phased implementation of these regulations will produce increasing emission reduction benefits from now until 2024 and beyond, as the regulated fleets are retrofitted, and as older and dirtier portions of the fleets are replaced with newer and cleaner models at an accelerated pace.

Further, ARB and the Sacramento Non-attainment Area district staff work closely on identifying and distributing incentive funds to accelerate cleanup of engines. Key incentive programs include: The Carl Moyer Program; the Goods Movement Program; the Lower-Emission School Bus Program; and the Air Quality Improvement Program (AQIP). These incentive-based programs work in tandem with regulations to accelerate deployment of cleaner technology.

II. LIGHT-DUTY VEHICLES, EMISSIONS STANDARDS, AND CLEAN FUEL

A. Emission Reduction

Figure 1 illustrates the trend in NOx emissions from light-duty vehicles and key programs contributing to those reductions. As a result of these efforts, light-duty vehicle emissions in the WNNA have been reduced significantly since 1990 and will continue to go down through 2024 due to the benefits of ARB's longstanding light-duty mobile source program. From today, light-duty vehicle NOx emissions are reduced by about 60 percent in 2024. Key light-duty programs include Advanced Clean Cars, On-Board Diagnostics, Reformulated Gasoline, Incentive Programs, and the Enhanced Smog Check Program.

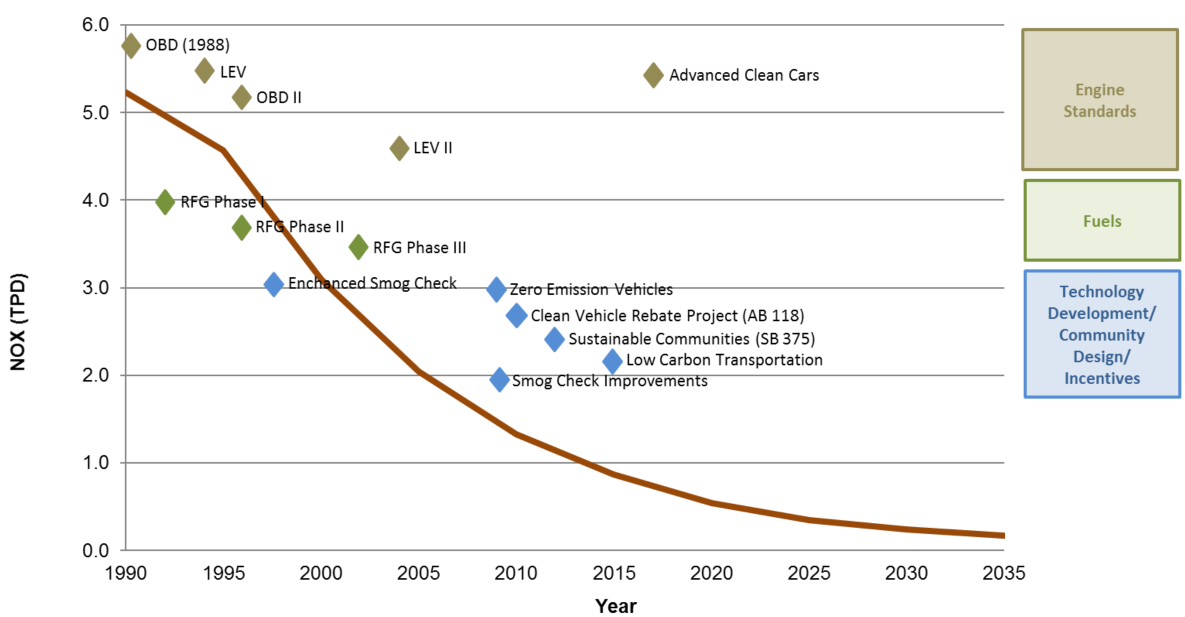


Figure 1: Key Programs to Reduce Light-Duty NOx Emissions

Since setting the nation's first motor vehicle exhaust emission standards in 1966 that led to the first pollution controls, California has dramatically tightened emission standards for light-duty vehicles. Through ARB regulations, today's new cars pollute 99 percent less than their predecessors did thirty years ago. In 1970, ARB required auto manufacturers to meet the first standards to control NOx emissions along with hydrocarbon emissions. The simultaneous control of emissions from motor vehicles and fuels led to the use of cleaner-burning reformulated gasoline (RFG) that has removed the emissions equivalent of 3.5 million vehicles from California's roads. Since ARB first adopted it in 1990, the Low Emission Vehicle Program (LEV and LEV II) and Zero-Emission Vehicle (ZEV) Program have resulted in the production and sales of hundreds of thousands of zero-emission vehicles (ZEVs) in California.

B. Advanced Clean Cars

ARB's groundbreaking Advanced Clean Cars (ACC) program is now providing the next generation of emission reductions in California, and ushering in a new zero emission passenger transportation system. The success of these programs is evident: California is the world's largest market for Zero Emission Vehicles (ZEVs), with over 21 models available today, and a wide variety are now available at lower price points, attracting new consumers. As of January 2015, Californians drive 40 percent of all ZEVs on the road in the United States, while the U.S. makes up about half of the world market. This movement towards commercialization of advanced clean cars has occurred due to ARB's ZEV regulation, part of ACC, which affects passenger cars and light-duty trucks.

ARB's ACC Program, approved in January 2012, is a pioneering approach of a 'package' of regulations that - although separate in construction - are related in terms of the synergy developed to address both ambient air quality needs and climate change. The ACC program combines the control of smog, soot causing pollutants and greenhouse gas emissions into a single coordinated package of requirements for model years 2015 through 2025. The program assures the development of environmentally superior cars that will continue to deliver the performance, utility, and safety vehicle owners have come to expect.

The ACC program approved by ARB in January 2012 also included amendments affecting the current ZEV regulation through the 2017 model year in order to enable manufacturers to successfully meet 2018 and subsequent model year requirements. These ZEV amendments are intended to achieve commercialization through simplifying the regulation and pushing technology to higher volume production in order to achieve cost reductions. The ACC Program benefits will increase over time as new cleaner cars enter the fleet displacing older and dirtier vehicles.

C. On Board Diagnostics

California's first OBD regulation required manufacturers to monitor some of the emission control components on vehicles starting with the 1988 model year. In 1989, ARB adopted OBD II, which required 1996 and subsequent model year passenger cars, light-duty trucks, and medium-duty vehicles and engines to be equipped with second generation OBD systems. OBD systems are designed to identify when a vehicle's emission control systems or other emission-related computer-controlled components are malfunctioning, causing emissions to be elevated above the vehicle manufacturer's specifications. ARB subsequently strengthened OBD II requirements and added OBD II specific enforcement requirements for 2004 and subsequent model year passenger cars, light-duty trucks, and medium-duty vehicles and engines.

D. Reformulated Gasoline

Since 1996, ARB has been regulating the formulation of gasoline resulting in California gasoline being the cleanest in the world. California's cleaner-burning gasoline regulation is one of the cornerstones of the State's efforts to reduce air pollution and cancer risk. Reformulated gasoline is fuel that meets specifications and requirements established by ARB. The specifications reduced motor vehicle toxics by about 40 percent and reactive organic gases by about 15 percent. The results from cleaning up fuel can have an immediate impact as soon as it is sold in the State. Vehicle manufacturers design low-emission emission vehicle to take full advantage of cleaner-burning gasoline properties.

E. Incentive Programs

There are a number of different incentive programs focusing on light-duty vehicles that produce extra emission reductions beyond traditional regulations. The incentive programs work in two ways, encouraging the retirement of dirty older cars and encouraging the purchase of a cleaner vehicle.

Voluntary accelerated vehicle retirement or "car scrap" programs provide monetary incentives to vehicle owners to retire older, more polluting vehicles. The purpose of these programs is to reduce fleet emissions by accelerating the turnover of the existing fleet and subsequent replacement with newer, cleaner vehicles. Both State and local vehicle retirement programs are available.

California's voluntary vehicle retirement program is administered by the Bureau of Automotive Repair (BAR) and provides $1,000 per vehicle and $1,500 for low-income consumers for unwanted vehicles that have either failed or passed their last Smog Check Test and that meet certain eligibility guidelines. This program is referred to as the Consumer Assistance Program.

The Enhanced Fleet Modernization Program (EFMP) was approved by the AB 118 legislation to augment the State's existing vehicle retirement program. Approximately $30 million is available annually through 2015 to fund the EFMP via a $1 increase in vehicle registration fees. ARB developed the program in consultation with BAR. The program is jointly administered by both BAR for vehicle retirement, and local air districts for vehicle replacement.

Other programs, in addition to vehicle retirement programs, help to clean up the light-duty fleet. The AQIP, established by AB 118, is an ARB voluntary incentive program to fund clean vehicle and equipment projects. The Clean Vehicle Rebate Project (CVRP) is one of the current projects under AQIP. CVRP, started in 2009, is designed to accelerate widespread commercialization of zero-emission vehicles and plug-in hybrid electric vehicles by providing consumer rebates up to $2,500 to partially offset the higher cost of these advanced technologies. The CVRP is administered statewide by the California Center for Sustainable Energy. In Fiscal Years 2009-2012, $26.1 million, including $2 million provided by the California Energy Commission, funded approximately 8,000 rebates. In June 2012, the ARB allocated up to $15-21 million to the CVRP as outlined in the AQIP FY2012-2013 Funding Plan.

III. HEAVY-DUTY TRUCKS, EMISSION STANDARDS, AND CLEAN FUEL

A. Emission Reduction

Figure 2 illustrates the trend in NOx emissions from heavy-duty vehicles and key programs contributing to those reductions. As a result of these efforts, heavy-duty vehicle emissions in the Sacramento Metropolitan Non-attainment Area have been reduced significantly since 1990 and will continue to go down through 2024 due to the benefits of ARB's longstanding heavy-duty mobile source program. From today, heavy-duty NOx emissions are reduced by about 50 percent in 2024. Key programs include Heavy-Duty Engine Standards, Clean Diesel Fuel, Truck and Bus Regulation and Incentive Programs.

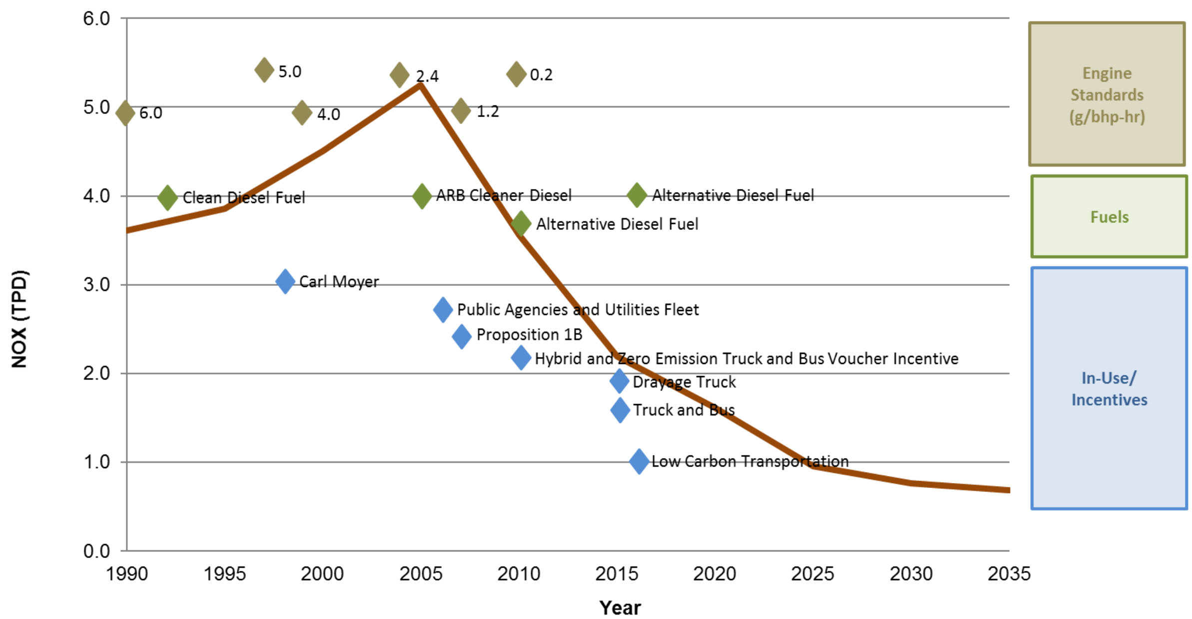


Figure 2: Key Programs to Reduce Heavy-Duty Emissions

B. Heavy-Duty Engine Standards

Since 1990, heavy-duty engine NOx emission standards have become dramatically more stringent, dropping from 6 grams per brake horsepower-hour (g/bhp-hr) in 1990 down to the current 0.2 g/bhp-hr standard, which took effect in 2010. In addition to mandatory NOx standards, there have been several generations of optional lower NOx standards put in place over the past 15 years. Most recently in 2015, engine manufacturers can certify to three optional NOx emission standards of 0.1 g/bhp-hr, 0.05 g/bhp-hr, and 0.02 g/bhp-hr (i.e., 50 percent, 75 percent, and 90 percent lower than the current mandatory standard of 0.2 g/bhp-hr). The optional standards allow local air districts and ARB to preferentially provide incentive funding to buyers of cleaner trucks, to encourage the development of cleaner engines.

C. Clean Diesel Fuel

Since 1993, ARB has required that diesel fuel have a limit on the aromatic hydrocarbon content and sulfur content of the fuel. Diesel powered vehicles account for a disproportionate amount of the diesel particulate matter which is considered a toxic air contaminant. In 2006, ARB required a low-sulfur diesel fuel to be used not only by on-road diesel vehicles but also for off-road engines. The diesel fuel regulation allows alternative diesel formulations as long as emission reductions are equivalent to the ARB formulation.

D. Cleaner In-Use Heavy-Duty Trucks (Truck and Bus Regulation)

The Truck and Bus Regulation was first adopted in December 2008. This rule represents a multi-year effort to turn over the legacy fleet of engines and replace them with the cleanest technology available. In December 2010, ARB revised specific provisions of the in-use heavy-duty truck rule, in recognition of the deep economic effects of the recession on businesses and the corresponding decline in emissions.

Starting in 2012, the Truck and Bus Regulation phases in requirements applicable to an increasingly larger percentage of the truck and bus fleet over time, so that by 2023 nearly all older vehicles would need to be upgraded to have exhaust emissions meeting 2010 model year engine emissions levels. The regulation applies to nearly all diesel-fueled trucks and buses with a gross vehicle weight rating (GVWR) greater than 14,000 pounds that are privately or federally owned, including on-road and off-road agricultural yard goats, and privately and publicly owned school buses. Moreover, the regulation applies to any person, business, school district, or federal government agency that owns, operates, leases or rents affected vehicles. The regulation also establishes requirements for any in-state or out-of-state motor carrier, California-based broker, or any California resident who directs or dispatches vehicles subject to the regulation. Finally, California sellers of a vehicle subject to the regulation would have to disclose the regulation's potential applicability to buyers of the vehicles. Approximately 170,000 businesses in nearly all industry sectors in California, and almost a million vehicles that operate on California roads each year are affected. Some common industry sectors that operate vehicles subject to the regulation include: for-hire transportation, construction, manufacturing, retail and wholesale trade, vehicle leasing and rental, bus lines, and agriculture.

ARB compliance assistance and outreach activities that are key in support of the Truck and Bus Regulation include:

- The Truck Regulations Upload and Compliance Reporting System, an online reporting tool developed and maintained by ARB staff;
- The Truck and Bus regulation's fleet calculator, a tool designed to assist fleet owners in evaluating various compliance strategies;
- Targeted training sessions all over the State; and
- Out-of-state training sessions conducted by a contractor.

ARB staff also develops regulatory assistance tools, conducts and coordinates compliance assistance and outreach activities, administers incentive programs, and actively enforces the entire suite of regulations. Accordingly, ARB's approach to ensuring compliance is based on a comprehensive outreach and education effort.

E. Incentive Programs

There are a number of different incentive programs focusing on heavy-duty vehicles that produce extra emission reductions beyond traditional regulations. The incentive programs encourage the purchase of a cleaner truck.

Several State and local incentive funding pools have been used historically -- and remain available -- to fund the accelerated turnover of on-road heavy-duty vehicles. Since 1998, the Carl Moyer Program (Moyer Program) has provided funding for replacement, new purchase, repower and retrofit of trucks. Beginning in 2008, the Goods Movement Emission Reduction Program funded by Proposition 1B has funded cleaner trucks for the region's transportation corridors; the final increment of funds will implement projects in through 2018.

The Air Quality Improvement Program has funded the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP) since 2010, and continued Northern Sierra Air Quality Management District participation is expected. ARB has also administered a Truck Loan Assistance Program since 2009.

IV. OFF-ROAD SOURCES, EMISSION STANDARDS, AND CLEAN FUEL

A. Emission Reduction

Off-road sources encompass equipment powered by an engine that does not operate on the road. Sources vary from ships to lawn and garden equipment and for example, include sources like locomotives, aircraft, tractors, harbor craft, off-road recreational vehicles, construction equipment, forklifts, and cargo handling equipment.

Figure 3 illustrates the trend in NOx emissions from off-road equipment and key programs contributing to those reductions. As a result of these efforts, off-road emissions in the WNNA have been reduced significantly since 1990 and will continue to go down through 2024 due to the benefits of ARB's and U.S. EPA longstanding programs. From today, off-road NOx emissions are reduced by about 25 percent in 2024. Key programs include Off-Road Engine Standards, Locomotive Engine Standards, Clean Diesel Fuel, Cleaner In-Use Off-Road Regulation and In-Use LSI Fleet Regulation.

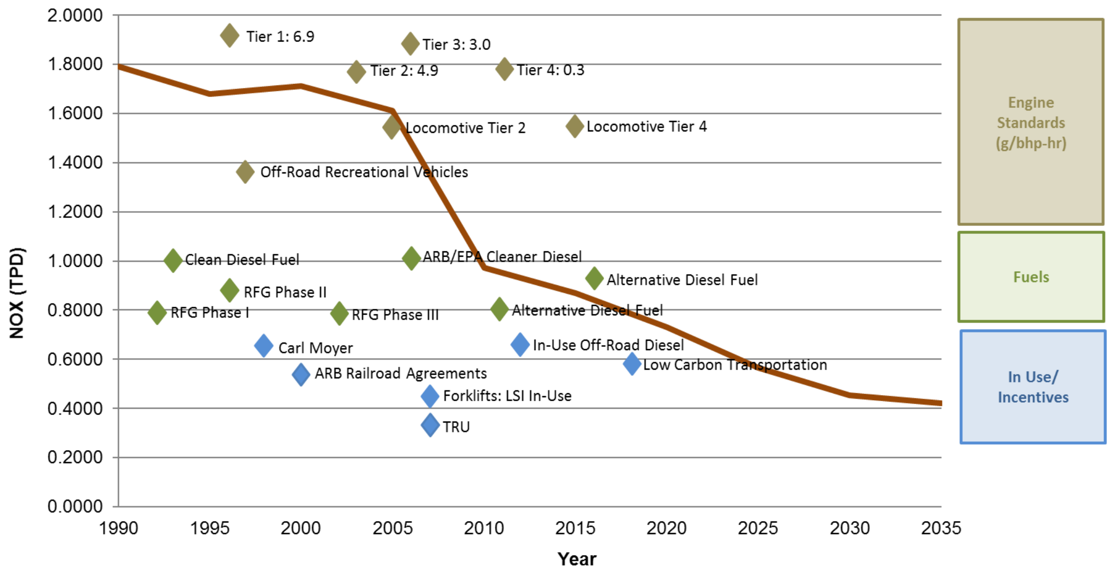


Figure 3: Key Programs to Reduce Off-Road Emissions

B. Off-Road Engine Standards

The Clean Air Act preempts states, including California, from adopting requirements for new off-road engines less than 175 HP used in farm or construction equipment. California may adopt emission standards for in-use off-road engines pursuant to Section 209(e)(2), but must receive authorization from U.S. EPA before it may enforce the adopted standards.

The Board first approved regulations to control exhaust emissions from small off-road engines (SORE) such as lawn and garden equipment in December 1990 with amendments in 1998 and 2003. These regulations were implemented through three tiers of progressively more stringent exhaust emission standards that were phased in between 1995 and 2008.

Manufacturers of forklift engines are subject to new engine standards for both diesel and Large Spark Ignition (LSI) engines. Off-road diesel engines were first subject to engine standards and durability requirements in 1996 while the most recent Tier 4 Final emission standards were phased in starting in 2013. Tier 4 emission standards are based on the use of advanced after-treatment technologies such as diesel particulate filters and selective catalytic reduction. LSI engines have been subject to new engine standards that include both criteria pollutant and durability requirements since 2001 with the cleanest requirements phased-in starting in 2010.

C. Locomotive Engine Standards

The Clean Air Act and the U.S. EPA national locomotive regulations expressly preempt states and local governments from adopting or enforcing “any standard or other requirement relating to the control of emissions from new locomotives and new engines used in locomotives” (U.S. EPA interpreted new engines in locomotives to mean remanufactured engines, as well). U.S. EPA has approved two sets of national locomotive emission regulations (1998 and 2008). In 1998, U.S. EPA approved the initial set of national locomotive emission regulations. These regulations primarily emphasized NOx reductions through Tier 0, 1, and 2 emission standards. Tier 2 NOx emission standards reduced older uncontrolled locomotive NOx emissions by up to 60 percent, from 13.2 to 5.5 g/bhphr.

In 2008, U.S. EPA approved a second set of national locomotive regulations. Older locomotives upon remanufacture are required to meet more stringent particulate matter (PM) emission standards which are about 50 percent cleaner than Tier 0-2 PM emission standards. U.S. EPA refers to the PM locomotive remanufacture emission standards as Tier 0+, Tier 1+, and Tier 2+. The new Tier 3 PM emission standard (0.1 g/bhphr), for model years 2012-2014, is the same as the Tier 2+ remanufacture PM emission standard. The 2008 regulations also included new Tier 4 (2015 and later model years) locomotive NOx and PM emission standards. The U.S. EPA Tier 4 NOx and PM emission standards further reduced emissions by approximately 95 percent from uncontrolled levels.

D. Clean Diesel Fuel

Since 1993, ARB has required that diesel fuel have a limit on the aromatic hydrocarbon content and sulfur content of the fuel. Diesel powered vehicles account for a disproportionate amount of the diesel particulate matter which is considered a toxic air contaminant. In 2006, ARB required a low-sulfur diesel fuel to be used not only by on-road diesel vehicles but also for off-road engines. The diesel fuel regulation allows alternative diesel formulations as long as emission reductions are equivalent to the ARB formulation.

E. Cleaner In-Use Off-Road Equipment (Off-Road Regulation)

The Off-Road Regulation which was first approved in 2007 and subsequently amended in 2010 in light of the impacts of the economic recession. These off-road vehicles are used in construction, manufacturing, the rental industry, road maintenance, airport ground support and landscaping. In December 2011, the Off-Road Regulation was modified to include on-road trucks with two diesel engines.

The Off-Road Regulation will significantly reduce emissions of diesel PM and NOx from the over 150,000 in-use off-road diesel vehicles that operate in California. The regulation affects dozens of vehicle types used in thousands of fleets by requiring owners to modernize their fleets by replacing older engines or vehicles with newer, cleaner models, retiring older vehicles or using them less often, or by applying retrofit exhaust controls.

The Off-Road Regulation imposes idling limits on off-road diesel vehicles, requires a written idling policy, and requires a disclosure when selling vehicles. The regulation also requires that all vehicles be reported to ARB and labeled, restricts the addition of older vehicles into fleets, and requires fleets to reduce their emissions by retiring, replacing, or repowering older engines, or installing verified exhaust retrofits. The requirements and compliance dates of the Off-Road Regulation vary by fleet size.

Fleets will be subject to increasingly stringent restrictions on adding older vehicles. The regulation also sets performance requirements. While the regulation has many specific provisions, in general by each compliance deadline, a fleet must demonstrate that it has either met the fleet average target for that year, or has completed the Best Available Control Technology requirements. The performance requirements of the Off-Road Regulation are phased in from January 1, 2014 through January 1, 2019.
Compliance assistance and outreach activities in support of the Off-Road Regulation include:

- The Diesel Off-road On-line Reporting System, an online reporting tool developed and maintained by ARB staff.
- The Diesel Hotline (866-6DIESEL), which provides the regulated public with questions about the regulations and access to ARB staff. Staff is able to respond to questions in English, Spanish and Punjabi.
- The Off-road Listserv, providing equipment owners and dealerships with timely announcement of regulatory changes, regulatory assistance documents, and reminders for deadlines.

F. LSI In-Use Fleet Regulation

Forklift fleets can be subject to either the LSI fleet regulation, if fueled by gasoline or propane, or the off-road diesel fleet regulation. Both regulations require fleets to retire, repower, or replace higher-emitting equipment in order to maintain fleet average standards. The LSI fleet regulation was originally adopted in 2007 with requirements beginning in 2009. While the LSI fleet regulation applies to forklifts, tow tractors, sweeper/scrubbers, and airport ground support equipment, it maintains a separate fleet average requirement specifically for forklifts. The LSI fleet regulation requires fleets with four or more LSI forklifts to meet fleet average emission standards.

Appendix D

Reasonably Available Control Measures Assessment

for Mobile Sources and Consumer Products

Reasonably Available Control Measures Assessment for Mobile Sources and Consumer Products

1. Overview

To fulfill the Clean Air Act (the Act) control measure requirements for ozone non-attainment areas, an assessment of control measures in the State Implementation Plan (SIP) must be performed. For ozone non-attainment areas, the control measures must be shown to be Reasonable Available Control Measures (RACM). ARB is responsible for measures to reduce emissions from mobile sources needed to attain the national ambient air quality standards (standards). This chapter will discuss how California's mobile source measures meet RACM.

Given the severity of California's air quality challenges, ARB has implemented the most stringent mobile source emissions control program in the nation. ARB'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, cleaner fuels that minimize emissions, and incentive programs to accelerate the penetration of the cleanest vehicles beyond that achieved by regulations alone. Taken together, California's mobile program meets RACM requirements in the context of ozone non-attainment.

2. RACM Requirements

Subpart 1, section 172(c)(1) of the Act requires SIPs to provide for the implementation of RACM as expeditiously as practicable. U.S. EPA has interpreted RACM to be those emission control measures that are technologically and economically feasible and when considered in aggregate, would advance the attainment date by at least one year.

ARB 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 ARB's regulatory authority that could contribute to expeditious attainment of the standard. First, ARB developed a series of technology assessments for heavy-duty mobile source applications and the fuels necessary to power them[29] along with ongoing review of advanced vehicle technologies for the light-duty sector in collaboration with U.S. EPA and the National Highway Traffic Safety Administration. ARB 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.

[29] Technology and Fuel assessments http://www.arb.ca.gov/msprog/tech/tech.htm

ARB staff released a discussion draft Mobile Source Strategy[30] 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 risk from transportation emissions over the next 15 years. ARB staff held a public workshop on October 16, 2015 in Sacramento, and on October 22, 2015, ARB held a public Board meeting to update the Board and solicit public comment on the Mobile Source Strategy in Diamond Bar.

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. On May 16, 2016, ARB released an updated Mobile Source Strategy and on May 17, 2016 ARB released the proposed State SIP strategy for a 45-day public comment period. The current mobile source program and proposed measures included in the State SIP Strategy provide attainment of the ozone standard as expeditiously as practicable and meet RFP requirements.

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 ZEV and 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, Mobile Cargo Handling Equipment for Heavy-Duty engines. Other Authorizations include Off-Highway Recreational Vehicles and the Portable Equipment Registration Program.

Finally, ARB obtained an authorization from U.S. EPA to enforce adopted emission standards for off-road engines used in yard trucks and two-engine sweepers. ARB 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 Act and do not require a waiver under section 209(b).

[30] 2016 Mobile Source Strategy http://www.arb.ca.gov/planning/sip/2016sip/2016mobsrc.htm

4. Light- and Medium-Duty Vehicles

Light- and medium-duty vehicles are currently regulated under California's Advanced Clean Cars program including the Low-Emission Vehicle III (LEV III) and Zero-Emission Vehicle (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. ARB is also active in implementing programs for owners of older dirtier vehicles to retire them early in favor of clean vehicles. The Air Quality Improvement Program (AQIP) is a voluntary incentive program to fund clean vehicles. The Clean Vehicle Rebate Project, a project under AQIP, provides monetary incentives for the purchase of zero-emission and plug-in hybrid electric vehicles. The "car scrap" programs, like the Enhanced Fleet Modernization Program, and Clean Vehicle Rebate Project provide monetary incentives to replace old vehicles with zero-emission vehicles.

Taken together, California's emission standards, fuel specifications, and incentive programs for on-road, light-, and medium-duty vehicles represent all measures that are technologically and economically feasible within California.

5. Heavy-Duty Vehicles

California's heavy-duty vehicle emissions control program includes requirements for increasingly tighter new engine standards and address 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 NOx and PM2.5 than trucks sold in 1986.

Most recently in the ongoing efforts to go beyond federal standards and achieve further reductions, ARB adopted the Optional Reduced Emissions Standards for Heavy-Duty Engines regulation in 2014 that establishes the new generation of optional NOx 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, ATCM 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. In addition, ARB's significant investment in incentive programs provides an additional mechanism to achieve maximum emission reductions from this source sector.

Taken together, California's emission standards, fuel specifications, and incentive programs for heavy-duty vehicles represent all measures that are technologically and economically feasible within California.

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.

Engines and equipment used in agricultural processes are unique to each process and are often re-designed and tailored to their particular use. Fleet turnover to cleaner engines is the focus for these engines.

Taken together, California's comprehensive suite of emission standards, fuel specifications, and incentive programs for off-road vehicles and engines represent all measures that are technologically and economically feasible within California and when considered in aggregate, would advance the attainment date by at least one year.

7. Other Sources and Fuels

The emission limits established for other mobile source categories, coupled with U.S. EPA 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 and BACM.

Cleaner burning fuels also play an important role in reducing emissions from motor vehicles and engines as ARB 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, fuel specifications, and incentive programs for other mobile sources and fuels represent all measures that are technologically and economically feasible within California.

8. Mobile Source Summary

California's long history of comprehensive and innovative emissions control has resulted in the most stringent mobile source control program in the nation. U.S. EPA has previously acknowledged the strength of the program in their approval of ARB's regulations and through the waiver process. In its 2011 approval of the San Joaquin Valley's 8-hour ozone plan, which included the State's current program and new measure commitments, U.S. EPA found that there were no further reasonably available control measures that would advance attainment of the standard in the San Joaquin Valley.

In addition, U.S. EPA has provided past determinations that ARB's mobile source control programs meet Best Available Control Measure (BACM) requirements, which are more stringent than RACM, as part of their 2004 approval of the San Joaquin Valley's 2003 PM10 Plan:

"We believe that the State's control programs constitute BACM at this time for the mobile source and fuels categories, since the State's measures reflect the most stringent emission control programs currently available, taking into account economic and technological feasibility."

Since then, ARB has continued to substantially enhance and accelerate reductions from our mobile source control programs through the implementation of more stringent engine emissions standards, in-use requirements, incentive funding, and other policies and initiatives as described in the preceding sections.

ARB finds that with the current mobile source control program, there are no additional reasonable available control measures that would advance attainment of the 75 ppb 8-hour ozone standard in the Eastern Kern Air Pollution Control District. There are no reasonable regulatory control measures excluded from use in this plan; therefore, there are no emissions reductions associated with unused regulatory control measures. As a result, California's mobile source control programs fully meet the requirements for RACM.

9. Consumer Products

Consumer products are defined as chemically formulated products used by household and institutional consumers. For more than twenty five years, ARB has taken actions pertaining to the regulation of consumer products. Three regulations have set VOC limits for 129 consumer product categories. These regulations, referred to as the Consumer Product Program, have been amended frequently, and progressively stringent VOC limits and reactivity limits have been established. These are: Regulation for Reducing VOC Emissions from Antiperspirants and Deodorants; Regulation for Reducing Emissions from Consumer Products; and Regulation for Reducing the Ozone Formed from Aerosol Coating Product Emissions, and the Tables of Maximum Incremental Reactivity Values.

Additionally, a voluntary regulation, the Alternative Control Plan has been adopted to provide compliance flexibility to companies. The program's most recent rulemaking occurred in 2013.

U.S. EPA also regulates consumer products. U.S. EPA's consumer products regulation was promulgated in 1998, however, federal consumer products VOC limits have not been revised since their adoption. U.S. EPA also promulgated reactivity limits for aerosol coatings. As with the general consumer products, California's requirements for aerosol coatings are more stringent than the U.S. EPA's requirements. Other jurisdictions, such as the Ozone Transport Commission states, have established VOC limits for consumer products which are modeled after the California program. However, the VOC limits typically lag those applicable in California.

In summary, California's Consumer Products Program, with the most stringent VOC requirements applicable to consumer products, meets RACM.

Appendix E

Modeling Attainment Demonstration

MODELING ATTAINMENT DEMONSTRATION

Photochemical Modeling for the 8-Hour Ozone State Implementation Plan in the Western Nevada county Non-attainment Area (WNNA)

Prepared by

California Air Resources Board

Northern Sierra Air Quality Management District

Prepared for

United States Environmental Protection Agency Region IX

August 31, 2018

TABLE OF CONTENTS

1. INTRODUCTION 8

2. APPROACH 8

2.1. METHODOLOGY 8

2.2. MODELING PERIOD 9

2.3. BASELINE DESIGN VALUES 11

2.4. BASE, REFERENCE, AND FUTURE YEARS 12

2.5. RELATIVE RESPONSE FACTORS 13

2.6. FUTURE YEAR DESIGN VALUE CALCULATION 14

3. METEOROLOGICAL MODELING 14

3.1. WRF MODEL SETUP 15

3.2. WRF MODEL RESULTS AND EVALUATION 17

3.2.1 PHENOMENOLOGICAL EVALUATION 22

4. EMISSIONS 27

4.1 EMISSIONS SUMMARIES 27

5. OZONE MODELING 28

5.1. CMAQ MODEL SETUP 28

5.2. CMAQ MODEL EVALUATION 31

5.2.1 DIAGNOSITC EVALUATION 36

5.3. RELATIVE RESPONSE FACTORS AND FUTURE YEAR DESIGN VALUES 41

5.4. UNMONITORED AREA ANALYSIS 41

SUPPLEMENTAL MATERIALS 44

LIST OF FIGURES

Figure 1. Trend in the Grass Valley (Grass Valley-Litton Building monitor) 8-hour ozone design value (DV) and the three-year average of the DV utilized in the model attainment demonstration. 10

Figure 2. WRF modeling domains (D01 36km; D02 12km; and D03 4km). 15

Figure 3. Meteorological monitoring sites utilized in the model results evaluation: The solid red circle markers represent the sites while the thick black line denotes the spatial extent and regional boundary of the Western Nevada county 8-hour ozone Non-attainment Area (WNNA). Numbers reflect the sites listed in Table 6. 18

Figure 4. Distribution of daily mean bias (left) and mean error (right) from May – September 2012. Results are shown for wind speed (top), temperature (middle), and RH (bottom). 21

Figure 5. Comparison of modeled and observed hourly wind speed (left), 2-meter temperature (center), and relative humidity (right), May – September 2012. 22

Figure 6. Grass Valley 24-hour back trajectories from every hour on July 12, 2012 at 3 m above ground level. The Grass Valley Litton Building ozone monitoring site is marked with a red star. 23

Figure 7. Surface wind field at 4:00 PST (top) and 16:00 PST (bottom) on July 12, 2012. Modeled wind field is shown with black wind vectors, while observations are shown in red. 24

Figure 8. Average wind field at 5:00 PST (top) and 12:00 PST (bottom) for the top 10 observed ozone days at Grass Valley Litton Building monitor in 2012. Modeled wind field is shown with black wind vectors, while observations are shown in red. 25

Figure 9. Modeled and observed at 12:00 UTC (top) and 00:00 UTC (bottom) 500 hPa geopotential height for the top 10 observed ozone days at Grass Valley monitor in 2012. 26

Figure 10. Monthly average biogenic ROG emissions for 2012 in the WNNA. 28

Figure 11. The CMAQ modeling domains used in this SIP modeling. The outer box of the top panel is the California statewide 12 km modeling domain, while the inner box shows the 4 km modeling domain covering Central California. The color scale and gray line contours denote the gradients in topography (km). The insert on the bottom shows a zoomed-in view of the spatial extent and approximate regional boundary of SFNA (Magenta line), WNNA (blue) and location of the Grass Valley site (circle marker). 30

Figure 12. Comparison of various statistical metrics, from the model attainment demonstration modeling, to the range of statistics from the 69 peer-reviewed studies summarized in Simon et al. (2012). (MDA denotes Maximum Daily Average). 37

Figure 13. Illustrates a typical ozone isopleth plot, where each line represents ozone mixing ratio, in 10 ppb increments, as a function of initial NO_x and VOC (or ROG) mixing ratio (adapted from Seinfeld and Pandis, 1998, Figure 5.15). General chemical regimes for ozone formation are shown as NO_x-disbenefit (red circle), transitional (blue circle), and NO_x-limited (green circle). 38

Figure 14. Site-specific average weekday and weekend maximum daily average 8-hour ozone for each year from 2000 to 2015 in the WNNA. The colored circle markers denote observed values while the magenta triangle markers denote the simulated baseline 2012 values. Points falling below the 1:1 dashed line represent a NO_x-disbenefit regime, those on the 1:1 dashed line represent a transitional regime, and those above the 1:1 dashed line represent a NO_x-limited regime. 40

Figure 15. Spatial distribution of the future 2020 DVs based on the unmonitored area analysis in the WNNA. Color scale is in ppb of ozone. 43

LIST OF TABLES

Table 1. Illustrates the data from each year that are utilized in the Design Value (DV) calculation for a specific year (DV Year), and the yearly weighting of data for the average DV calculation (or DV_R)....11

Table 2. Year-specific 8-hour ozone design values for 2013, 2014 and 2015, and the average baseline design value (represented as the average of three design values) for 2013 at the Grass Valley site located in the WNNA. 11

Table 3. Description of CMAQ model simulations....13

Table 4. WRF vertical layer structure....16

Table 5. WRF Physics Options. 16

Table 6. Meteorological site location and parameter measured....17

Table 7. Hourly surface wind speed, temperature and relative humidity statistics by region for May through September, 2012. IOA denotes index of agreement.18

Table 8. Summer Planning Emissions for 2012 and 2020 (tons/day). 27

Table 9. CMAQ configuration and settings. 29

Table 10. Daily maximum 8-hour ozone performance statistics in the WNNA for the 2012 ozone season (May - September)....32

Table 11. Daily maximum 1-hour ozone performance statistics in the WNNA for the 2012 ozone season (May - September)....34

Table 12. Hourly ozone performance statistics in the WNNA for the 2012 ozone season (May - September). Note that only statistics for the grid cell in which the monitor is located were calculated for hourly ozone. 35

Table 13. Summary of key parameters related to the calculation of future year 2020 8-hour ozone design values (DV) at the Grass Valley-Litton Building monitoring site in the WNNA. Note that final future year DVs are truncated, and fractional values are shown for reference only....41

ACRONYMS

ARB – Air Resources Board

BCs – Boundary Conditions

CMAQ Model – Community Multi-scale Air Quality Model

DV – Design Value

GEOS-5 – Goddard Earth Observing System Model, Version 5

GMAO – Global Modeling and Assimilation Office

ICs – Initial Conditions

MDAB – Mojave Desert Air Basin

MDA8 – Maximum Daily Average 8-hour Ozone

MOZART – Model for Ozone and Related chemical Tracers

NASA – National Aeronautics and Space Administration

NARR - North American Regional Reanalysis

NCAR – National Center for Atmospheric Research

NOAA - National Oceanic and Atmospheric Administration

NO_x – Oxides of nitrogen

OFP - Ozone Forming Potential

ROG – Reactive Organic Gases

RH – Relative Humidity

RRF – Relative Response Factor

SAPRC – Statewide Air Pollution Research Center

SFNA – Sacramento Federal Non-attainment Area

SIP – State Implementation Plan

SJV – San Joaquin Valley

SJVAB – San Joaquin Valley Air Basin

SoCAB – South Coast Air Basin

U.S. EPA – United States Environmental Protection Agency

VOCs – Volatile Organic Compounds

WNNA – Western Nevada county Non-attainment Area

WRF Model – Weather and Research Forecast Model

1. INTRODUCTION

The purpose of this document is to present the findings of the model attainment demonstration for the 0.075 ppm (or 75 ppb) 8-hour ozone standard in the Western Nevada county 8-hour ozone Non-attainment Area (WNNA), which forms the scientific basis for the WNNA 2018 8-hour ozone SIP. The 75 ppb standard was promulgated by the U.S. EPA in 2008 and became effective in 2010. Currently, the WNNA is designated as a moderate ozone non-attainment area for this standard and is mandated to show attainment by 2017. However, since the WNNA exceeded the 75 ppb ozone standard in 2017, the region will almost certainly be reclassified as serious non-attainment, which will extend the attainment deadline until 2020. As a result, the focus of this model attainment demonstration will be on the 2020 future year.

Findings from the model attainment demonstration are summarized for the Grass Valley design site monitor located within the non-attainment area. The general approach utilized in the attainment demonstration is described in Section 2, while the remaining sections discuss the meteorological modeling (Section 3), the emissions inventory (Section 4), and the photochemical modeling and results (Section 5). A more detailed description of the modeling and development of the model-ready emissions inventory is presented in the Photochemical Modeling Protocol and Modeling Emissions Inventory Appendices.

2. APPROACH

This section describes the Air Resources Board's (ARB's) procedures, based on U.S. EPA guidance[31], for projecting ozone Design Values (DVs) to the future using model output and a Relative Response Factor (RRF) approach in order to show future year attainment of the 0.075 ppm 8-hour ozone standard.

2.1. METHODOLOGY

The U.S. EPA modeling guidance[1] 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[32], which was utilized in past 8-hour ozone SIPs in California's Central Valley, the 2009 Sacramento SIP[33] and the 2007 San Joaquin Valley (SJV) SIP[34] for the 0.08 ppm 8-hour ozone standard, the current guidance recommends utilizing modeling in a relative sense. A brief

---

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

[32] U.S. EPA, 2007. Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze. EPA-454/B07-002, 2007, available at https://www.epa.gov/ttn/scram/guidance/guide/final-03-pm-rh-guidance.pdf

[33] 2009 Sacramento Regional 8-Hour Ozone Attainment and Reasonable Further Progress Plan, available at http://www.airquality.org/ProgramCoordination/Documents/4)%202013%20SIP%20Revision%20Report%201997%20Std.pdf

[34] 2007 Plan for the 1997 8-Hour Ozone Standard available at http://www.valleyair.org/Air_Quality_Plans/AQ_Final_Adopted_Ozone2007.htm

summary of how models are applied in the attainment demonstration, as prescribed by U.S. EPA modeling guidance[35], is provided below. A more detailed description of the methodology provided below and in subsequent sections is available in the Photochemical Modeling Protocol Appendix.

2.2. MODELING PERIOD

The Western Nevada County 8-hour ozone Non-attainment Area (WNNA), a region of highly complex terrain that extends from the foothills of the Sierra Nevada mountain range to the west and into the Tahoe National Forest to the east, is located downwind of the Sacramento and Bay Area emission source regions. The transported pollutants from these upwind source regions contribute to the exceedances of the federal ozone NAAQS in this region.

Attainment of the 8-hour ozone 75 ppb NAAQS at a monitor is determined based on the design value (DV), which is the three-year average of the observed annual 4th highest 8-hour ozone mixing ratio at a site. The trend in the WNNA's 8-hour ozone design values[36] exhibited a steady decline from 96 ppb in 2000 to 77 ppb in 2013. However, in recent years, DV's have shown an upward trend with DV's increasing from 77 ppb in 2013 to 81 ppb in 2015, 84 ppb in 2016, and 87 ppb in 2017[37] (Figure 1). Preliminary data for 2018 suggest that the increasing trend may be leveling off.

The variability in the WNNA DV may be attributed to various factors that govern ozone levels in this region, including complex terrain, meteorological conditions that facilitate the transport of ozone and its precursors from upwind source regions, and local emissions from anthropogenic and naturally occurring reactive biogenic ROG sources. In addition, the formation of ozone and the associated chemistry along the transport pathways and the prevailing ozone chemistry regimes both locally and in the upwind source regions play an important role in determining ozone levels in the region. Further details on the regional topography, flow patterns and conceptual model for ozone formation in the WNNA region can be found in the Modeling Protocol Appendix.

---

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

[36] ARB's Ambient Air Quality Data Summaries database available at https://www.arb.ca.gov/adam/trends/trends1.php

[37] Data for 2017 are preliminary and subject to further review available from https://www.arb.ca.gov/aqmis2/ozone_annual.php

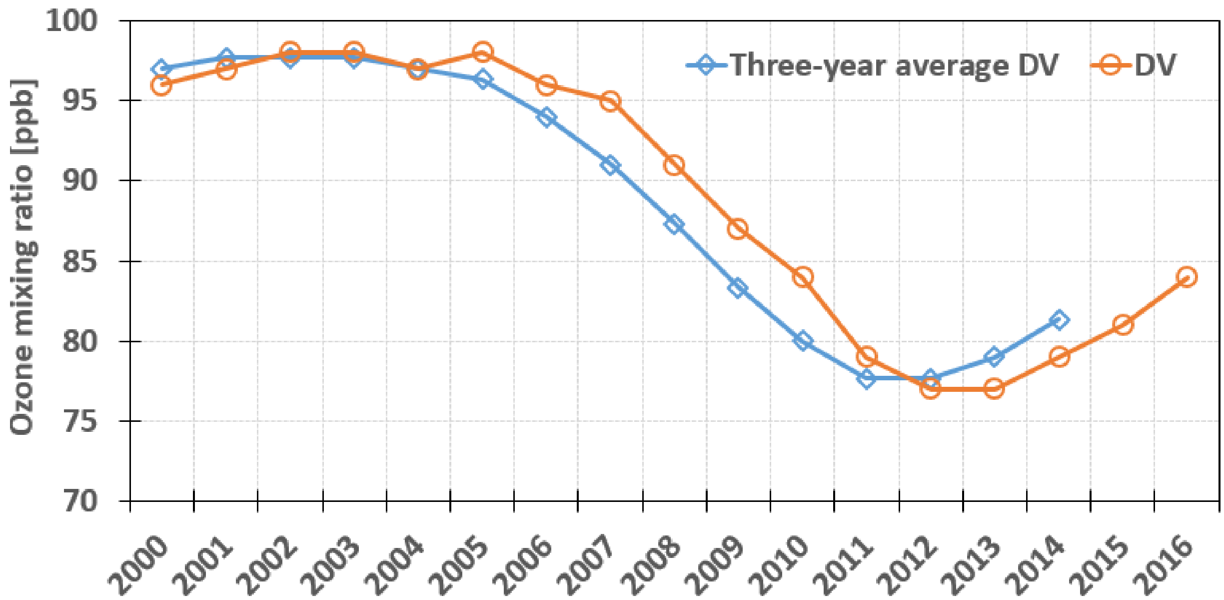


Figure 1. Trend in the Grass Valley (Grass Valley-Litton Building monitor) 8-hour ozone design value (DV) and the three-year average of the DV utilized in the model attainment demonstration.

The year 2012 was selected for the baseline modeling, while 2013 was selected as the baseline year for DV calculation in the model attainment test. The selection of 2012 as the baseline modeling year was based on an analysis of how conducive the recent years' meteorology were towards ozone formation, as well as the availability of the most detailed emissions inventory. Considering the recent upward trend in the WNNA DVs from 2013 onwards (described earlier in this section), 2013 was chosen as the baseline year for DV calculation as opposed to 2012, in order to better account for the recent shift in the DV trend (discussed further in Section 5.3).

The moderate non-attainment designation for the WNNA requires that attainment of the 2008 8-hour ozone standard be demonstrated by 2017. However, given that the WNNA exceeded the 8-hour ozone standard in 2017, the non-attainment area will likely be reclassified as serious non-attainment, with an attainment date of 2020. Therefore, 2020 was chosen as the primary future year modeled in this attainment demonstration.

The revised U.S. EPA modeling guidance[3] requires that the 8-hour ozone model attainment demonstration utilize the top ten modeled days when projecting design values to the future. Recent ozone SIP modeling applications in California[38,39] have generally simulated the entire ozone season (May – September) as the peak ozone mixing ratios tend to occur between June and September. The same May to September period was modeled in this attainment

[38] 2016 Plan for the 2008 8-Hour Ozone Standard available at http://www.valleyair.org/Air_Quality_Plans/Ozone-Plan-2016.htm
[39] 2013 Plan for the Revoked 1-Hour Ozone Standard available at http://www.valleyair.org/Air_Quality_Plans/Ozone-OneHourPlan-2013.htm

demonstration for 2012 and 2020 to ensure that all of the top ozone days in the WNNA were simulated.

2.3. BASELINE DESIGN VALUES

Specifying the baseline DV is a key consideration in the model attainment test, since this value is projected forward and used to test for future attainment at each site. The starting point for the attainment demonstration is with the observational based DV, which represents the three-year average (current year and prior two years) of the annual 4th highest 8-hour ozone mixing ratio observed at a specific monitor for the year under consideration. For example, a DV for 2013 would represent the average of the 4th highest 8-hour ozone mixing ratio from 2011, 2012, and 2013.

The U.S. EPA recommends using an average of three DVs that straddle the baseline year in order to better account for the year-to-year variability inherent in meteorology. Since 2013 was chosen as the base year for projecting DVs to the future, site-specific DVs were calculated for the three three-year periods ending in 2013, 2014, and 2015 and then these three DVs were 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 1 illustrates the observational data from each year that goes into the calculation of average DV at a particular monitoring site.

Table 1. Illustrates the data from each year that are utilized in the Design Value (DV) calculation for a specific year (DV Year), and the yearly weighting of data for the average DV calculation (or DV_R).

DV Year	**Years Averaged for the Design Value (4th highest observed 8-hr O_3)**				
2013	2011	2012	2013		
2014		2012	2013	2014	
2015			2013	2014	2015

Table 2 lists the 8-hour design values for the Grass Valley monitoring site, which are utilized in this model attainment demonstration. The ozone DVs increased from 77 ppb in 2013 to 81 ppb in 2015 with an average baseline design value of 79 ppb for the 2013-2015 period.

Table 2. Year-specific 8-hour ozone design values for 2013, 2014 and 2015, and the average baseline design value (represented as the average of three design values) for 2013 at the Grass Valley site located in the WNNA.

Site	8-hr Ozone Design Value (ppb)

(County, Air Basin)	2013	2014	2015	2013-2015 Average
Grass Valley-Litton Building (Grass Valley, MCAB[40])	77	79	81	79

2.4. BASE, REFERENCE, AND FUTURE YEARS

The model attainment demonstration consists of the following three primary model simulations, which all utilized the same model inputs, including meteorology, chemical boundary conditions, and biogenic emissions. The only difference between the simulations was in the year represented by the anthropogenic emissions (2012 or 2020) and certain day-specific emissions.

1. Base Year (or Base Case) 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, and exceptional events like the Chevron refinery fire in the Bay Area, which occurred over 6 days from August 19-24, 2012.

2. Reference (or Baseline) Year 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 there are two categories/emissions sources that were excluded: 1) wildfires, 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 and 2) the Chevron refinery fire mentioned above.

3. Future Year Simulation

The future year simulation is identical to the reference year simulation, except that projected future year (2020) anthropogenic emission levels 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.

To summarize (Table 3), the base year 2012 simulation was used for evaluating model performance, while the reference (or baseline) 2012 and future year 2020 simulations were used to project the baseline DVs to the future as described in the Photochemical Modeling Protocol Appendix and in subsequent sections of this document.

[40] MCAB denotes the Mountain Counties Air Basin.

Table 3. Description of CMAQ model simulations.

Simulation	Anthropogenic Emissions	Biogenic Emissions	Meteorology	Chemical Boundary Conditions
Base year (2012)	2012 w/ wildfires and Chevron refinery fire	2012 MEGAN	2012 WRF	2012 MOZART
Reference year (2012)	2012 w/o wildfires and w/o Chevron refinery fire	2012 MEGAN	2012 WRF	2012 MOZART
Future year (2020)	2020 w/o wildfires and w/o Chevron refinery fire	2012 MEGAN	2012 WRF	2012 MOZART

2.5. RELATIVE RESPONSE FACTORS

As part of the model attainment demonstration, the fractional change in ozone mixing ratio between the model reference year and model future year were calculated at each of the monitors. These ratios, called "relative response factors" (RRFs), were calculated based on the ratio of future year modeled maximum daily average 8-hour (MDA8) ozone to modeled reference year MDA8 ozone (Equation 1).

$$RRF = \frac{\text{average MDA8 ozone}_{\text{future}}}{\text{average MDA8 ozone}_{\text{reference}}} \qquad (1)$$

The MDA8 values, used in calculating the RRF, were based on the maximum simulated ozone within a 3x3 array of cells with the grid cells containing the monitor located at the center of the array[41]. The future and reference year ozone values used in the RRF calculations were paired in space and time (i.e., using the future year MDA8 ozone for the same modeled day and at the same grid cell where the MDA8 ozone for the reference year is located within the 3x3 array of cells). The modeled days utilized in the RRF calculation were selected based on the following U.S. EPA recommended criteria[1].

- Begin with days that have simulated baseline MDA8 >= 60 ppb and calculate RRFs based on the top 10 high ozone days.
- If there are fewer than 10 days with MDA8 >= 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 is not calculated at that monitor.
- Restrict the simulated days used in the RRF calculation by only including days with reference MDA8 within +/- 20% of the observed value at the monitor. This ensures that only modeled days which are consistent with the observed ozone levels are used in the RRF calculation.

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

RRFs were calculated for future year 2020 at the Grass Valley monitoring site following the procedure described above and discussed in Section 5.3.

2.6. FUTURE YEAR DESIGN VALUE CALCULATION

Future year design values for each site were calculated by multiplying the corresponding baseline design value (Table 2) by the site-specific RRF (Equation 2).

$$DV_F = DV_R \times RRF \qquad (2)$$

where,

DV_F = the future year design value,
DV_R = the reference year design value (from Table 2), and
RRF = the site specific RRF from Equation 1

Future year design values from the model attainment demonstration are discussed in Section 5.3.

3. 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. In summertime, the majority of the storm tracks are far away to the north of the state and a semi-permanent Pacific high typically sits off the California coast. Interactions between this eastern Pacific subtropical high pressure system and the thermal low pressure further inland over the Central Valley or South Coast lead to conditions conducive to pollution buildup[42,43] over large portions of the state.

The WNNA is the portion of Nevada County west of the crest of the Sierra Nevada Mountains. It is located to the northeast and downwind of the broader Sacramento region, and extends from the foothills, at the intersection of the Sacramento Valley and the Sierra Nevada mountain range, to the west and into the Tahoe National Forest to the east. The air flow into the WNNA is typically from the south-southwest[44], which means the region is regularly impacted by emissions and polluted air masses from within the Sacramento urban source region.
In the past, the ARB has utilized both prognostic and diagnostic meteorological models, as well as hybrid approaches in an effort to develop meteorological fields for use in air quality modeling

[42] Fosberg, M.A., Schroeder, M.J., Marine air penetration in Central California, Journal of Applied Meteorology, 5, 573-589, 1966.
[43] Bao, J.W., Michelson, S.A., Persson, P.O.G., Djalalova, I.V., Wilczak, J.M., Observed and WRF-simulated low-level winds in a high-ozone episode during the Central California ozone study, Journal of Applied Meteorology and Climatology, 47, 2372-2394, 2008.
[44] U.S. EPA, Technical Support Document for 2008 Ozone NAAQS Designations (https://www3.epa.gov/region9/air/ozone/pdf/R9_CA_NevadaCounty_FINAL.pdf)

that most accurately represent the meteorological processes that are important to air quality[45]. In this work, the state-of-the-science Weather and Research Forecasting (WRF) prognostic model[46] version 3.6 was utilized to develop the meteorological fields used in the subsequent photochemical model simulations.

3.1. WRF MODEL SETUP

The WRF meteorological modeling domain consisted of three nested Lambert projection grids of 36-km (D01), 12-km (D02), and 4-km (D03) horizontal grid spacing (Figure 2). WRF was run simultaneously for the three nested domains with two-way feedback between the parent and the nested grids. The D01 and D02 grids were used to resolve the larger scale synoptic weather systems, while the D03 grid resolved the finer details of the atmospheric conditions and was used to drive the air quality model simulations. All three domains utilized 30 vertical sigma layers (defined in Table 4), with the major physics options for each domain listed in Table 5.

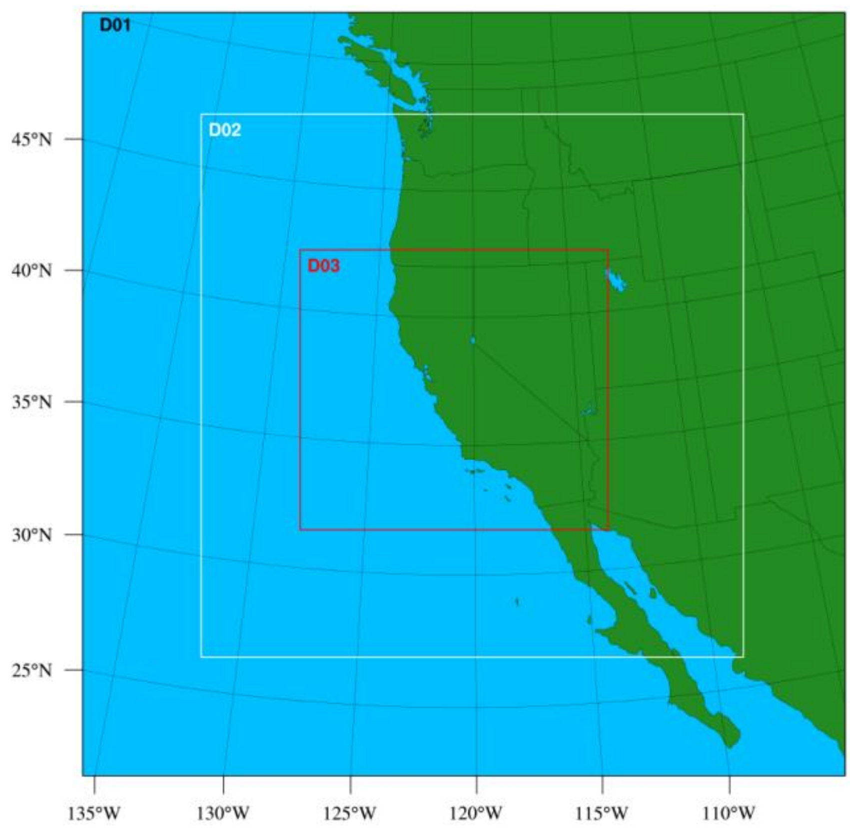


Figure 2. WRF modeling domains (D01 36km; D02 12km; and D03 4km).

Initial and boundary conditions (IC/BCs) for the WRF modeling were based on the 32-km horizontal resolution North American Regional Reanalysis (NARR) data that are archived at the

---

[45] Jackson, B.S., Chau, D., Gurer, K., Kaduwela, A.: Comparison of ozone simulations using MM5 and CALMET/MM5 hybrid meteorological fields for the July/August 2000 CCOS episode, *Atmos. Environ.*, 40, 2812-2822, 2006.

[46] Skamarock, W. C., J. B. Klemp, J. Dudhia, D. O. Gill, D. M. Barker, W. Wang, and J. G. Powers, 2005: A description of the Advanced Research WRF Version 2. NCAR Tech Notes-468+STR

National Center for Atmospheric Research (NCAR). Boundary conditions to WRF were updated at 6-hour intervals for the 36-km grid (D01). In addition, surface and upper air observations obtained from NCAR were used to further refine the analysis data that were used to generate the IC/BCs. Analysis nudging was employed in the outer 36-km grid (D01) to ensure that the simulated meteorological fields were constrained and did not deviate from the observed meteorology. No nudging was used on the two inner domains to allow model physics to work fully without externally imposed forcing[47].

Table 4. WRF vertical layer structure.

Layer Number	Height (m)	Layer Thickness (m)	Layer Number	Height (m)	Layer Thickness (m)
30	16082	1192	14	1859	334
29	14890	1134	13	1525	279
28	13756	1081	12	1246	233
27	12675	1032	11	1013	194
26	11643	996	10	819	162
25	10647	970	9	657	135
24	9677	959	8	522	113
23	8719	961	7	409	94
22	7757	978	6	315	79
21	6779	993	5	236	66
20	5786	967	4	170	55
19	4819	815	3	115	46
18	4004	685	2	69	38
17	3319	575	1	31	31
16	2744	482	0	0	0
15	2262	403			

Note: Shaded layers denote the subset of vertical layers used in the CMAQ photochemical model simulations.

Table 5. 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

[47] Rogers, R.E., Deng, A., Stauffer, D. Gaudet, B.J., Jia, Y., Soong, S.-T., Tanrikulu, S., Application of the Weather Research and Forecasting model for air quality modeling in the San Francisco Bay area, Journal of Applied Meteorology and Climatology, 52, 1953-1973, 2013.

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

3.2. WRF MODEL RESULTS AND EVALUATION

Simulated surface wind speed, temperature, and relative humidity from the 4 km domain were validated against hourly observations from 17 surface stations in the region surrounding and upwind of the WNNA (Figure 3). The observational data for the surface stations were obtained from the ARB archived meteorological database available at http://www.arb.ca.gov/aqmis2/aqmis2.php. Table 6 lists the monitoring stations and the meteorological parameters that are measured at each station, including wind speed and direction (wind), temperature (T) and relative humidity (RH). Figure 3 shows the location of each of these sites with the solid red circle markers denoting the sites while the black lines denote the regional boundary of the WNNA.

Several quantitative performance metrics were used to compare hourly surface observations and modeled estimates: mean bias (MB), mean error (ME) and index of agreement (IOA) based on the recommendations from Simon et al. (2012)[48]. The model performance statistical metrics were calculated using the available data at all the sites. A summary of these statistics for the area is shown in Table 7.

Table 6. Meteorological site location and parameter measured.

Site Number (Figure 3)	**Site ID**	**Site Name**	**Parameter(s) Measured**
1	3452	Pike County Lookout	Wind, T, RH
2	4768	Reader Ranch	Wind, T, RH
3	5744	Browns Valley	T, RH
4	2958	Yuba City-Almond Street	Wind, T
5	3196	Cool-Highway 193	Wind, T
6	5832	Auburn #3	T, RH
7	3290	Lincoln (RAWS)	Wind, T, RH
8	3291	Pilot Hill Station	Wind, T, RH

[48] Simon, H., Baker, K. R., and Phillips, S.: Compilation and interpretation of photochemical model performance statistics published between 2006 and 2012, *Atmospheric Environment*, 61, 124-139, 2012

9	2956	Roseville-N Sunrise Blvd	Wind, T, RH
10	3187	Folsom-Natoma Street	Wind, T, RH
11	5776	Fair Oaks #2	T, RH
12	2731	Sacramento-Del Paso Manor	Wind, T, RH
13	5799	Bryte	T, RH
14	3011	Sacramento-T Street	Wind, T, RH
15	2143	Davis-UCD Campus	Wind, T
16	3209	Sloughhouse	Wind
17	2977	Elk Grove-Bruceville Road	Wind, T, RH

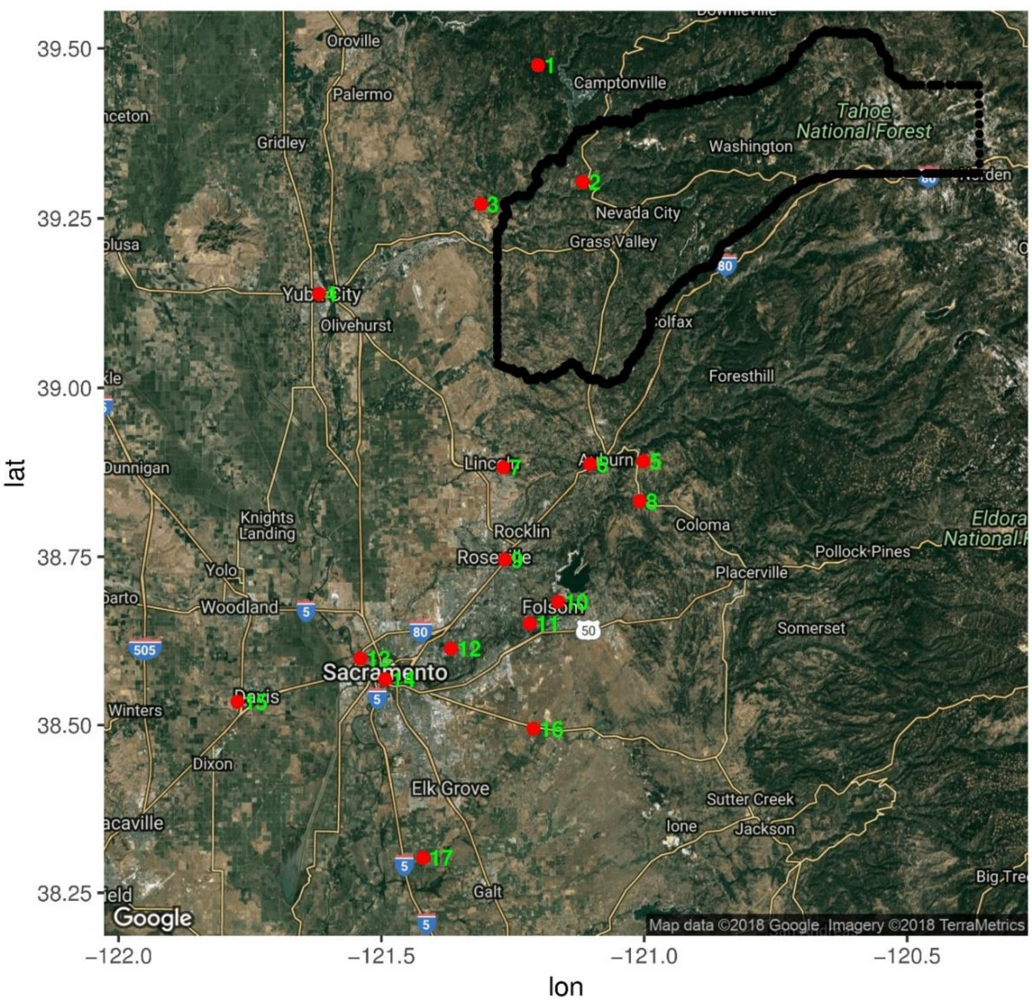


Figure 3. Meteorological monitoring sites utilized in the model results evaluation: The solid red circle markers represent the sites while the thick black line denotes the spatial extent and regional boundary of the Western Nevada county 8-hour ozone Non-attainment Area (WNNA). Numbers reflect the sites listed in Table 6.

Table 7. Hourly surface wind speed, temperature and relative humidity statistics by region for May through September, 2012. IOA denotes index of agreement.

Observed Mean	Modeled Mean	Mean Bias	Mean Error	IOA
Wind Speed (m/s)				
2.14	2.61	0.47	1.04	0.70
Temperature (K)				
295.52	295.14	-0.38	2.45	0.94
Relative Humidity (%)				
44.77	50.24	5.47	12.85	0.80

The distribution of daily mean bias and mean error are shown in Figure 4 while observed vs. modeled scatter plots of hourly wind speed, temperature, and relative humidity are shown in Figure 5. The average hourly wind speed bias for May-September 2012 is relatively small at 0.47 m/s, while the average mean error is 1.04 m/s. The index of agreement for the wind speed in this period is 0.70. Temperature is biased low with an average bias of -0.38 K, while the IOA for temperature is 0.94. Consistent with the negative temperature bias, relative humidity has a positive bias of 5.47%.

These results are comparable to other recent WRF modeling efforts in California investigating ozone formation in Central California[49] and modeling analyses for the CalNex and CARES field studies[50,51,52,53]). Detailed hourly time-series of surface temperature, wind speed, and wind direction for the area along with spatial distribution of the mean bias and mean error can be found in the supplementary material.

---

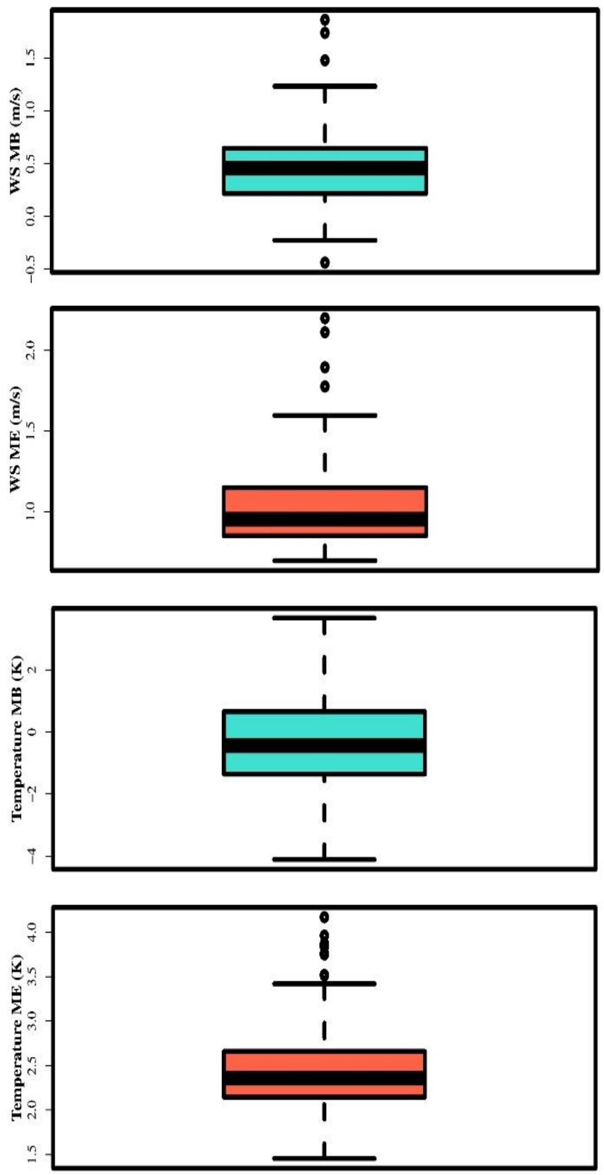
[49] Hu, J., Howard, C. J., Mitloehner, F., Green, P. G., and Kleeman, M. J.: Mobile Source and Livestock Feed Contributions to Regional Ozone Formation in Central California, *Environmental Science & Technology*, 46, 2781-2789, 2012.

[50]Fast, J. D., Gustafson Jr, W. I., Berg, L. K., Shaw, W. J., Pekour, M., Shrivastava, M., Barnard, J. C., Ferrare, R. A., Hostetler, C. A., Hair, J. A., Erickson, M., Jobson, B. T., Flowers, B., Dubey, M. K., Springston, S., Pierce, R. B., Dolislager, L., Pederson, J., and Zaveri, R. A.: Transport and mixing patterns over Central California during the carbonaceous aerosol and radiative effects study (CARES), *Atmos. Chem. Phys.,* 12, 1759-1783, 2012, doi:10.5194/acp-12-1759-2012.

[51]Baker, K. R., Misenis, C., Obland, M. D., Ferrare, R. A., Scarino, A. J., and Kelly, J. T.: Evaluation of surface and upper air fine scale WRF meteorological modeling of the May and June 2010 CalNex period in California, *Atmos. Environ.*, 80, 299-309, 2013.

[52] Kelly, J. T., Baker, K. R., Nowak, J. B., Murphy, J. G., Milos, Z. M., VandenBoer, T. C., Ellis, R. A., Neuman, J. A., Weber, R. J., Roberts, J. M., Veres, P. R., de Gouw, J. A., Beaver, M. R., Newman, S., and Misenis, C.: Fine-scale simulation of ammonium and nitrate over the South Coast Air Basin and San Joaquin Valley of California during CalNex-2010, *J. Geophysical Research,* 119, 3600-3614, doi:10.1002/2013JD021290.

[53] Angevine, W. M., Eddington, L., Durkee, K., Fairall, C., Bianco, L., Brioude, J.: Meteorological model evaluation for CalNex 2010, *Monthly Weather Review*, 140, 3885-3906, 2012.


WS MB (m/s)
−0.5
0.0
0.5
1.0
1.5
WS ME (m/s)
1.0
1.5
2.0
Temperature MB (K)
−4
−2
0
2
Temperature ME (K)
1.5
2.0
2.5
3.0
3.5
4.0

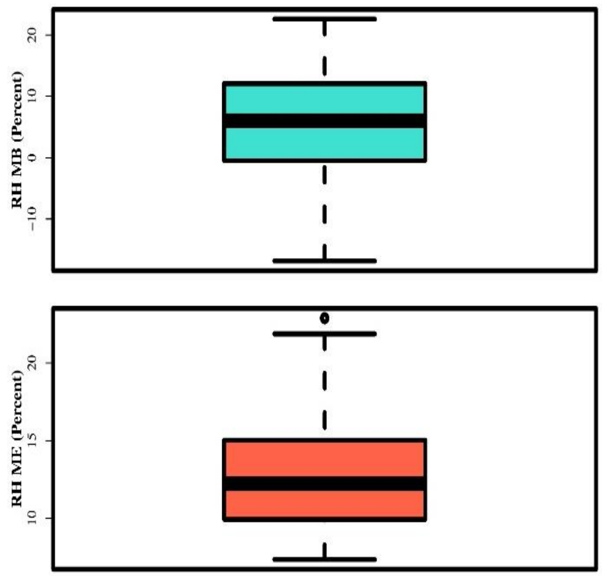


Figure 4. Distribution of daily mean bias (left) and mean error (right) from May – September 2012. Results are shown for wind speed (top), temperature (middle), and RH (bottom).

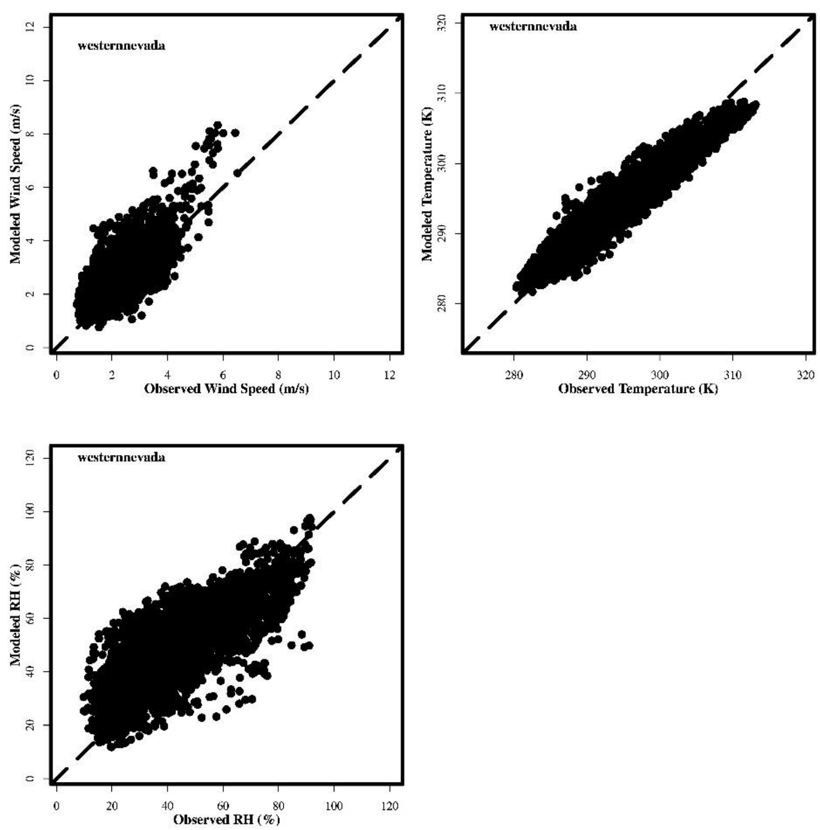


Figure 5. Comparison of modeled and observed hourly wind speed (left), 2-meter temperature (center), and relative humidity (right), May – September 2012.

3.2.1 PHENOMENOLOGICAL EVALUATION

Conducting a detailed phenomenological evaluation for all modeled days can be resource intensive given that the entire ozone season (May – September) was modeled for the attainment demonstration. However, some insight and confidence that the model is able to reproduce the meteorological conditions leading to elevated ozone can be gained by investigating the meteorological conditions during peak ozone days within the WNNA in more detail.

Past observations and analyses have shown that the WNNA is subject to pollution transport from the south-south west including from the Sacramento metropolitan area[54] [55]. Its meteorology is also expected to be influenced by upslope and downslope winds associated with the surrounding terrain. Figure 6 shows the 24-hour back trajectories from every hour on July 12, 2012 at the Grass Valley Litton Building ozone monitoring site. The highest 8-hour ozone concentration at the site in 2012 occurred on this day. The trajectories were calculated with the HYSPLIT model[56] driven by WRF meteorology. These back trajectories are typical of a high ozone day at the Grass Valley monitor, and demonstrate that the transport pathways are generally from the southwest. Some of the trajectories have a circular pattern around the Grass Valley site indicating downslope and upslope flow impacts, and which illustrates that the model is able to reproduce these complex transport pathways to and within the WNNA.

Meteorological conditions that produced peak ozone levels in the area occurred on July 12, 2012, with a daily maximum 8-hour ozone mixing ratio of 81 ppb observed at the Grass Valley ozone monitoring site. The upper-level weather charts showed that a 500 mb high pressure system was observed over California and most of the Southwest US on that day. At the surface, the Reader Ranch monitor, near the Grass Valley ozone monitoring site, observed a daily high close to 104 ˚F for two consecutive days on July 11th and 12th.

Figure 7 shows the surface wind fields in the early morning (4:00 PST) and the afternoon (16:00 PST) on July 12, 2012 with the observed and modeled values denoted by red and black arrows, respectively. Overall, modeled winds compare relatively well with the observed values, with winds during the early morning hours being influenced by downslope flows, while afternoon winds were impacted by upslope flows over the mountain counties. Winds in the Sacramento Valley show an influence from both the Coastal Ranges to the west and the Sierra Nevada Range to the east. At 4:00 PST, the wind field had an eddy like pattern over the Yolo and Solano areas,

---

[54] California Air Resources Board, 1998: Tracking the Sacramento pollutant plume over the western Sierra Nevada, Contract No. 94-334, Final Report.

[55] Van Ooy, D.J. and Carroll, J.J.: The spatial variation of ozone climatology on the western slope of the Sierra Nevada, Atmospheric Environment, 29, 1319-1330, 1995.

[56] Stein, A.F., Draxler, R.R, Rolph, G.D., Stunder, B.J.B., Cohen, M.D., and Ngan, F.: NOAA's HYSPLIT atmospheric transport and dispersion modeling system, Bulletin of the American Meteorological Society, 96, 2059-2077, 2015

indicating the occurrence of the Schultz eddy along the west side of the valley. These wind field patterns are consistent with the conceptual model for ozone transport and formation within the region, as described in the Photochemical Modeling Protocol Appendix.

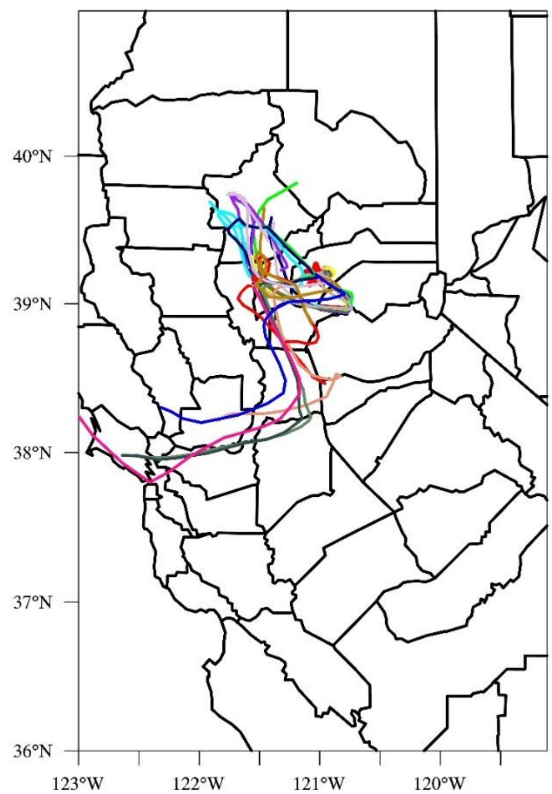


Figure 6. Grass Valley 24-hour back trajectories from every hour on July 12, 2012 at 3 m above ground level. The Grass Valley Litton Building ozone monitoring site is marked with a red star.

Since RRF calculations in the model attainment test described in Section 2.5 are based on the top 10 peak ozone days, the modeled and measured winds in the region were examined in further detail for the top 10 ozone days observed at the Grass Valley site in 2012. The ten highest daily maximum 8-hour ozone mixing ratios observed at the Grass Valley Litton Building site in 2012 occurred on July 12, July 13, August 30, August 3, August 31, August 16, September 2, September 4, May 9, and June 18, respectively. Figure 8 shows the mean wind field (vector average) for the top 10 ozone days at 05:00 PST and 12:00 PST, respectively. Overall, the surface wind distribution indicates that the model is in general agreement with the observations and is able to capture many of the important features of the observed meteorological fields on those days when elevated ozone levels occurred.

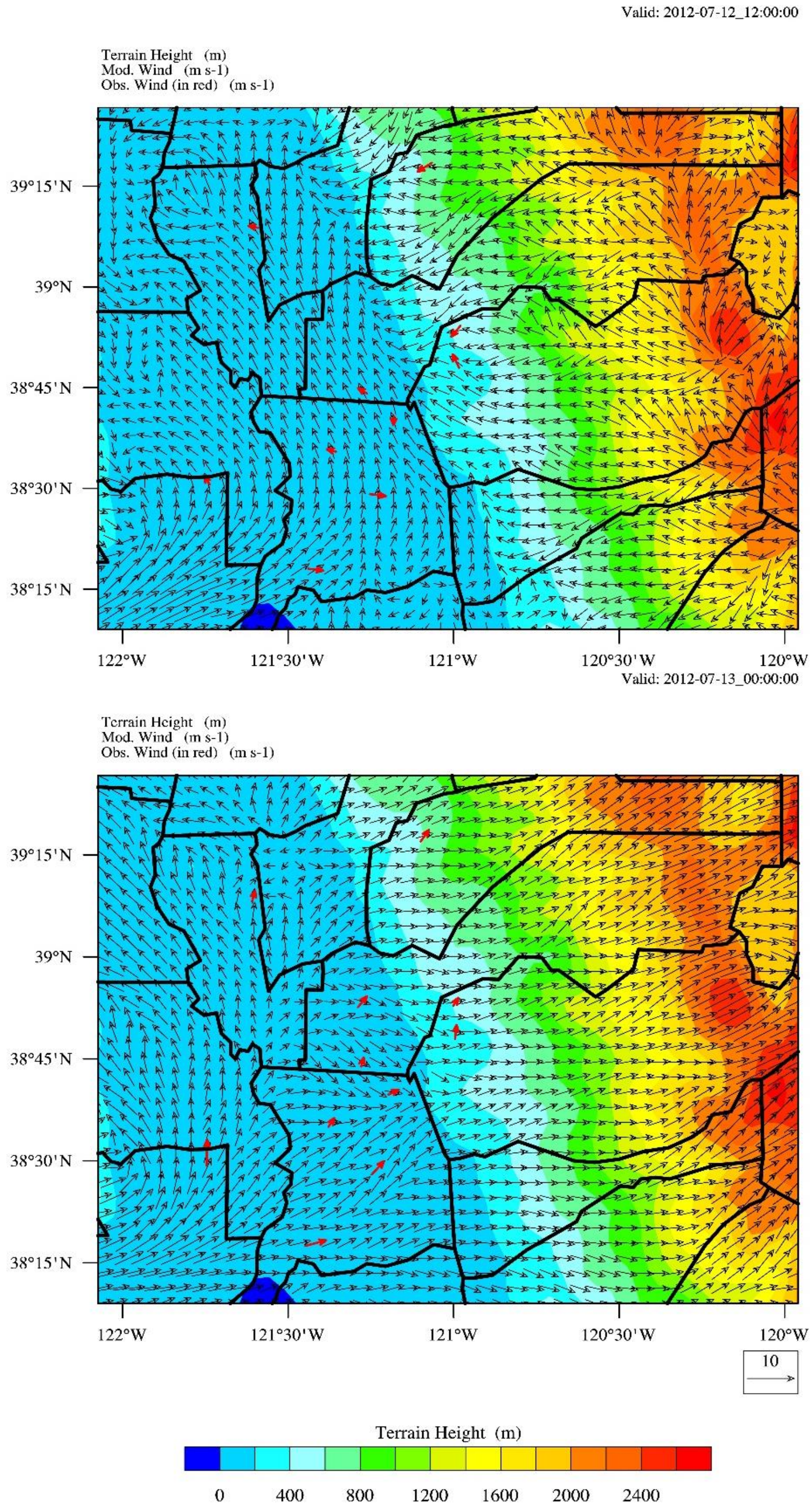


Figure 7. Surface wind field at 4:00 PST (top) and 16:00 PST (bottom) on July 12, 2012. Modeled wind field is shown with black wind vectors, while observations are shown in red.

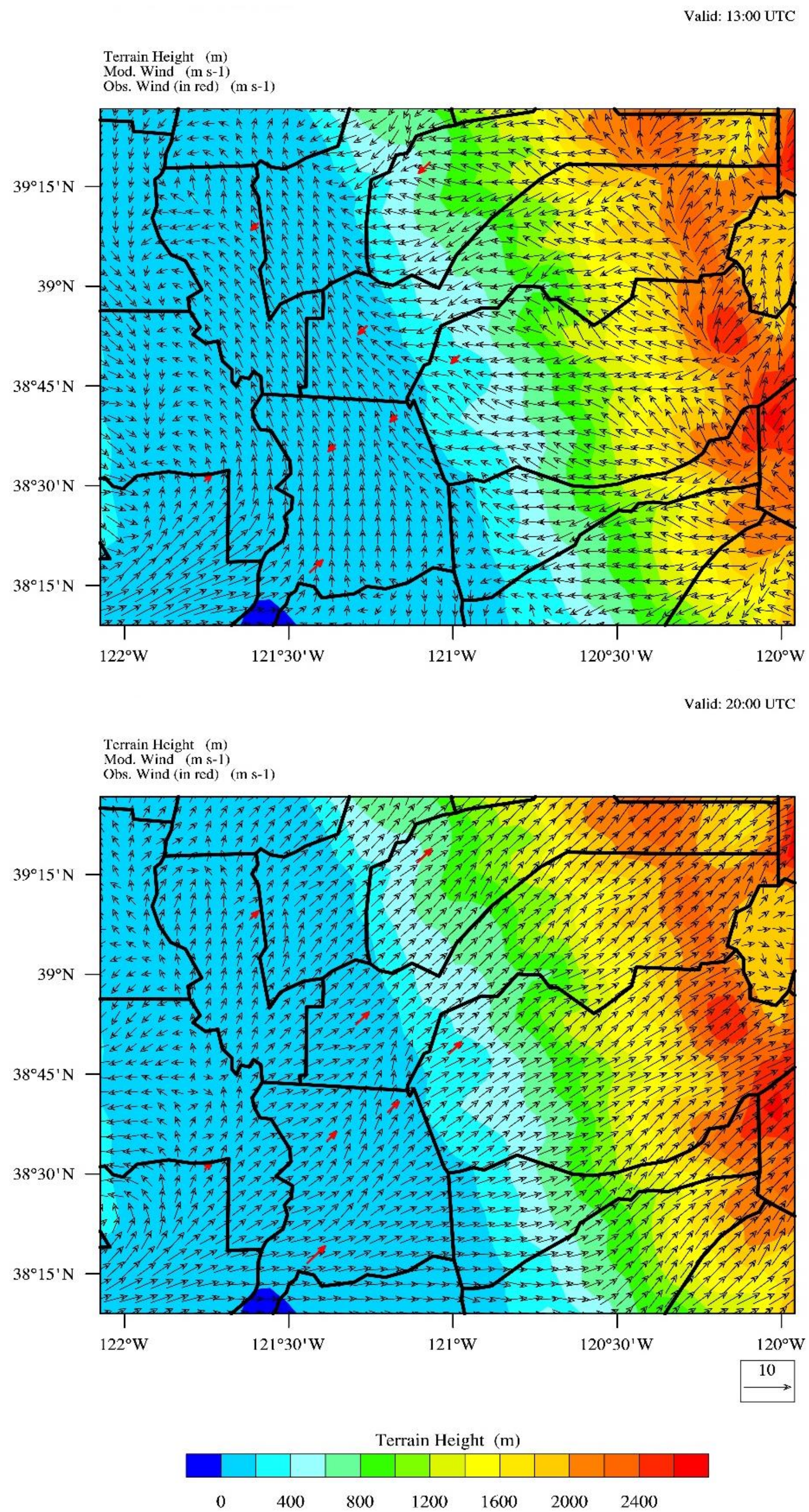


Figure 8. Average wind field at 5:00 PST (top) and 12:00 PST (bottom) for the top 10 observed ozone days at Grass Valley Litton Building monitor in 2012. Modeled wind field is shown with black wind vectors, while observations are shown in red.

Figure 9 shows the 500 hPa geopotential height at 12:00 UTC and 00:00 UTC for the top 10 ozone days in 2012 at the Grass Valley site. These times were chosen to coincide with timing of the upper-air observations in the region. In this figure, the North American Regional Reanalysis (NARR) data is used to represent the observations. The NARR dataset is a product of observational data assimilated (including upper-air observations) into some of the NOAA model products for the purpose of producing a snap shot of the weather over North America at any given time. The 500 hPa geopotential height is a useful metric to evaluate, because it is one of the major parameters related to regional synoptic patterns. It can be seen from Figure 9 that on average the 500 hPa geopotential height is ~5800 m above sea level on these peak ozone days, and the modeled 500 hPa geopotential height closely matches the observed values.

Although a phenomenological evaluation of only a subset of peak ozone days does not necessarily mean the model performs equally well on all days, the fact that the model can adequately reproduce wind flows consistent with the ozone conceptual model, combined with reasonable performance statistics over the ozone season (Table 7), provides added confidence in the meteorological fields utilized for this attainment demonstration modeling.

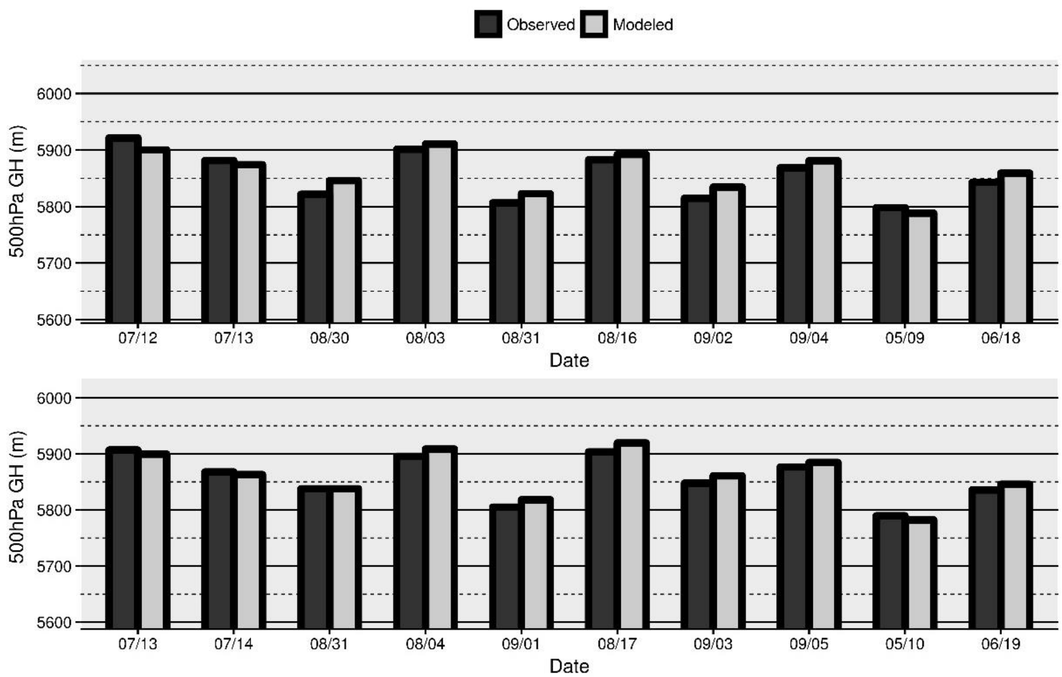


Figure 9. Modeled and observed at 12:00 UTC (top) and 00:00 UTC (bottom) 500 hPa geopotential height for the top 10 observed ozone days at Grass Valley monitor in 2012.

4. 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). 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.

4.1 EMISSIONS SUMMARIES

The transport of pollutants from the Sacramento Federal Non-attainment Area (SFNA) can significantly contribute to the exceedances of the federal ozone NAAQS in the WNNA. As such, it is useful to not only summarize the change in emissions from 2012 to 2020 in the WNNA, but also in the Sacramento Valley, since emissions from these areas are readily transported into the WNNA (see Table 8).

Table 8. Summer Planning Emissions for 2012 and 2020 (tons/day).

Western Nevada Non-attainment Area						
Source Category	NOx			ROG		
	2012	2020		2012	2020	
	[tpd]	[tpd]	% diff[#]	[tpd]	[tpd]	% diff[#]
Stationary	0.106	0.096	-9.4	0.702	0.785	11.8
Area	0.135	0.138	2.2	1.394	1.515	8.7
On-Road Mobile	3.976	2.160	-45.7	1.793	1.007	-43.8
Other Mobile	0.944	0.738	-21.8	1.327	0.958	-27.8
Total	5.160	3.131	-39.3	5.215	4.265	-18.2
Sacramento Federal Non-attainment Area (SFNA)						
Source Category	NOx			ROG		
	2012	2020		2012	2020	
	[tpd]	[tpd]	% diff[#]	[tpd]	[tpd]	% diff[#]
Stationary	9.026	7.497	-16.9	20.528	21.838	6.4
Area	2.702	2.146	-20.6	28.504	29.014	1.8
On-Road Mobile	61.963	29.446	-52.5	35.031	17.390	-50.4
Other Mobile	29.993	24.123	-19.6	25.682	18.568	-27.7
Total	103.684	63.212	-39.0	109.745	86.810	-20.9

[#] % diff denotes percent difference with respect to 2012 emission levels.

Overall, anthropogenic NO_x was projected to decrease ~39% between 2012 and 2020 (from 5.2 tpd to 3.1 tpd) in the WNNA. In contrast, anthropogenic ROG was projected to decrease ~18% by 2020 (from 5.2 tpd to 4.3 tpd). In the upwind Sacramento Metropolitan Area, the magnitude of the anthropogenic NO_x and ROG emissions is roughly 10 times that of the WNNA, while the relative change from 2012 to 2020 is comparable to the relative change in the WNNA.

Monthly biogenic ROG totals for 2012 within the WNNA are shown in Figure 10 (note that the same biogenic emissions were used in the 2012 and 2020 modeling). Throughout the summer, biogenic ROG emissions ranged from ~129.3 tpd in May to 268 and 279.5 tpd in July and August, with the difference in emissions primarily due to differences in temperature, solar radiation, and leaf area from month-to-month.

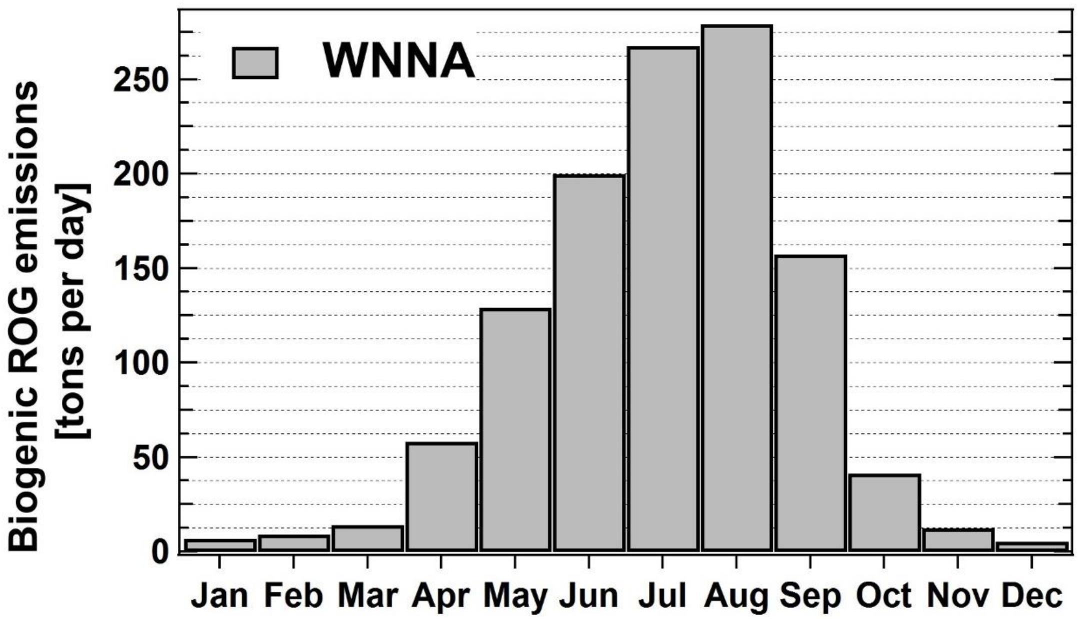


Figure 10. Monthly average biogenic ROG emissions for 2012 in the WNNA.

5. OZONE MODELING

5.1. CMAQ MODEL SETUP

Figure 11 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 107x97 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 (dashed black line) covering the Central valley region, including the San Joaquin Valley, Sacramento Valley, Mountain Counties air basins and the WNNA, has a finer scale 4 km grid resolution and includes 192x192 lateral grid cells.

The 12 km and 4 km 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, 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 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 4.

The photochemical modeling for this attainment demonstration utilized CMAQ version 5.0.2, released by the U.S. EPA (https://www.cmascenter.org/cmaq/) in May 2014. The SAPRC07 mechanism was selected as the photochemical mechanism for the CMAQ simulations. Further details of the CMAQ configuration used in this work are summarized in Table 9 and in the Photochemical Modeling Protocol Appendix. The same configuration was used for all simulations including the base, reference, and future years. CMAQ was compiled using the Intel FORTRAN compiler version 12.

Table 9. 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 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 concentrations)

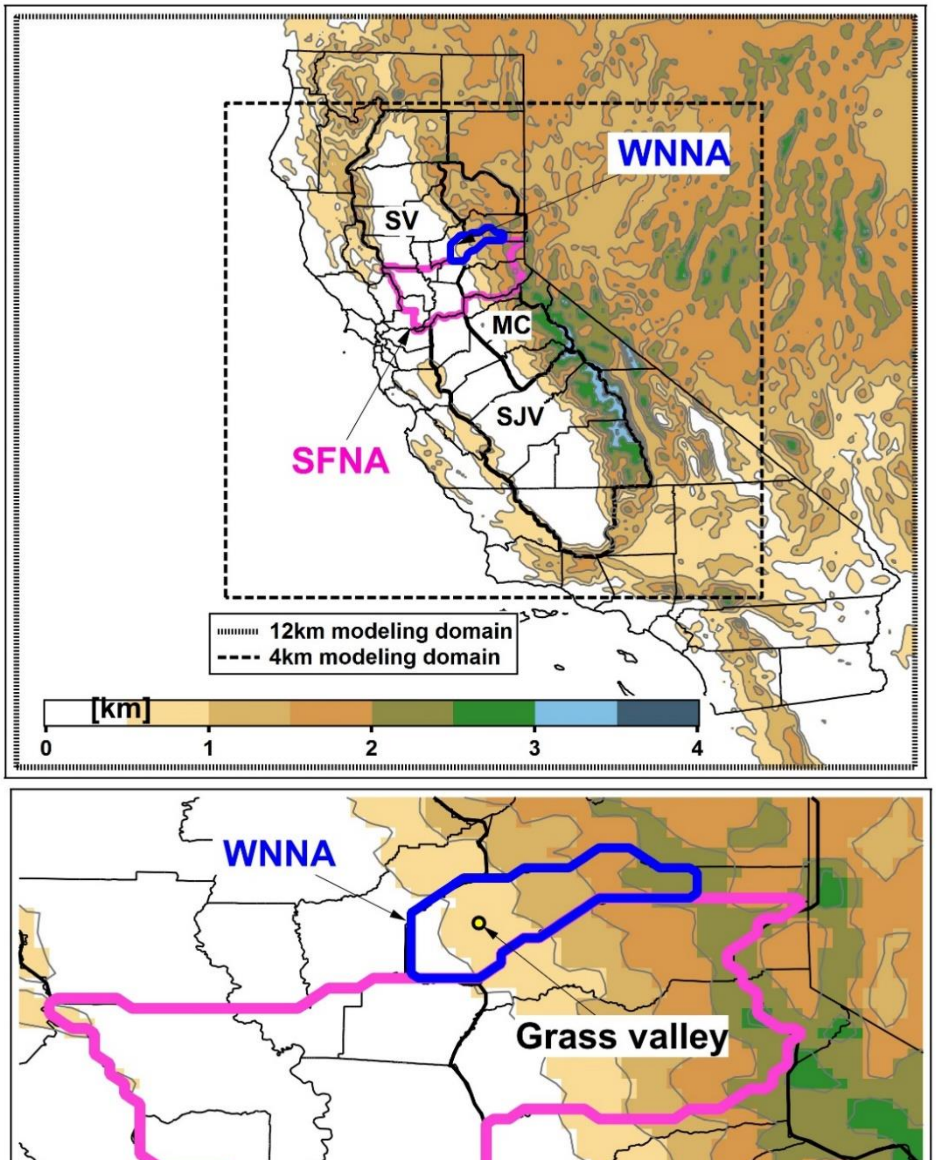


Figure 11. The CMAQ modeling domains used in this SIP modeling. The outer box of the top panel is the California statewide 12 km modeling domain, while the inner box shows the 4 km modeling domain covering Central California. The color scale and gray line contours denote the gradients in topography (km). The insert on the bottom shows a zoomed-in view of the spatial extent and approximate regional boundary of SFNA (Magenta line), WNNA (blue) and location of the Grass Valley site (circle marker).

The entire ozone season (May – September) was simulated through individual monthly simulations conducted in parallel. 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 for the first day were set to the default initial conditions included with the CMAQ release. The 4 km inner domain simulations utilized a three day spin-up period, with initial conditions derived from output from the corresponding day of the 12 km domain simulation.

Chemical boundary conditions (BCs) 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., 2010[57]). The MOZART-4 data for 2012 were obtained from the National Center for Atmospheric Research (NCAR; http://www.acom.ucar.edu/wrf-chem/mozart.shtml) for 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 for all simulations (e.g., Base, Reference, Future, and any sensitivity simulation). The inner 4 km domain simulations utilized BCs that were based on output from the corresponding day of the 12 km domain simulation.

5.2. CMAQ MODEL EVALUATION

Observed ozone data from the Air Quality and Meteorological Information System (AQMIS) database (www.arb.ca.gov/airqualitytoday/) was used to evaluate the accuracy of the 4 km CMAQ modeling for the ozone monitors listed in Table 2. The U.S. EPA modeling guidance[58] recommends using model output from the grid cell in which the monitor is located in the operational evaluation of the model predictions. However, the future year design value calculations (discussed in Sections 2.5 and 2.6) are based on simulated values > 60 ppb near the monitor (i.e., the maximum simulated ozone within a 3x3 array of grid cells with the grid cell containing the monitor located at the center of the array). Hence, model performance was evaluated at each monitor by comparing observations against the simulated values using only data above the 60 ppb threshold at the monitored grid cell as well as the peak grid cell within the 3x3 grid array centered on the monitor (i.e., the 3x3 maximum).

As recommended by U.S. EPA[1], a number of statistical metrics have been used to evaluate the model performance for ozone. These metrics include mean bias (MB), mean error (ME), mean fractional bias (MFB), mean fractional error (MFE), normalized mean bias (NMB), normalized

---

[57] Emmons, L. K., Walters, S., Hess, P. G., Lamarque, J.-F., Pfister, G. G., Fillmore, D., Granier, C., Guenther, A., Kinnison, D., Laepple, T., Orlando, J., Tie, X., Tyndall, G., Wiedinmyer, C., Baughcum, S. L., and Kloster, S.: Description and evaluation of the Model for Ozone and Related chemical Tracers, version 4 (MOZART-4), Geosci. Model Dev., 3, 43-67, doi:10.5194/gmd-3-43-2010, 2010.

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

mean error (NME), root mean square error (RMSE), and correlation coefficient (R^2). In addition, the following plots were used in evaluating the modeling: time-series comparing predictions and observations, scatter plots for comparing the magnitude of simulated and observed mixing ratios, box plots to summarize the time series data across different averaging times, as well as frequency distributions.

The model performance evaluation is presented for the Grass Valley-Litton Building site in the WNNA. Performance statistics for data above 60 ppb are reported separately for different ozone metrics including 8-hour daily maximum ozone, 1-hour daily maximum ozone, and hourly ozone (all hours of the day) for the monitored grid cell as well as the 3x3 maximum. Performance statistics for Maximum Daily Average 8-hour ozone (MDA8) are shown in Table 10.

Overall, when simulated data extracted at the grid cell is used for comparison with observations, the model shows a slight negative bias in MDA8 ozone greater than 60 ppb in the WNNA (-4.1 ppb). However, when the 3x3 maximum is used, the negative bias in the model is reduced by 0.7 ppb (from -4.1 ppb to -3.4 ppb). Mean error shows a slight increase from 5.7 ppb to 6.2 ppb in the WNNA when the 3x3 maximum is considered. Similar statistics for daily maximum 1-hour ozone and hourly ozone can be found in Table 11 and Table 12, respectively.

Model performance statistics within the range of values shown in Tables 10, 11 and 12 are consistent with previous studies in California and studies elsewhere in the U.S. Hu et al. (2012)[59], simulated an ozone episode in central California (July 27 – August 2, 2000) using a different chemical mechanism and found that modeled bias ranged from -2.7 to -10.8 ppb for daily maximum 8-hour ozone (compared to -4.1 and -3.4 ppb for the WNNA in this work) and -3.6 to -12.7 ppb for daily maximum 1-hour ozone in Central California (compared to -3.6 and -0.9 ppb in this work).

Table 10. Daily maximum 8-hour ozone performance statistics in the WNNA for the 2012 ozone season (May - September).

Daily Maximum 8-hour ozone > 60 ppb with simulated data extracted at grid cell where the monitor is located	
Parameter	**WNNA**
Number of data points	27
Mean obs (ppb)	68.4
Standard Deviation obs (ppb)	3.6
Mean Bias (ppb)	-4.1

59 Hu, J., Howard, C. J., Mitloehner, F., Green, P. G., and Kleeman, M. J.: Mobile Source and Livestock Feed Contributions to Regional Ozone Formation in Central California, *Environmental Science & Technology*, 46, 2781-2789, 2012.

Mean Error (ppb)	5.7
RMSE (ppb)	7.4
Normalized Mean Bias (%)	-6
Normal Mean Error (%)	8.4
R-squared	0.09
Index of Agreement	0.55

Daily Maximum 8-hour ozone > 60 ppb with simulated data extracted from the 3x3 grid cell array maximum centered at the monitor

Parameter	WNNA
Number of data points	32
Mean obs (ppb)	68.9
Standard Deviation obs (ppb)	6.2
Mean Bias (ppb)	-3.4
Mean Error (ppb)	6.2
RMSE (ppb)	7.4
Normalized Mean Bias (%)	-4.9
Normal Mean Error (%)	4.9
R-squared	0.04
Index of Agreement	0.52

Table 11. Daily maximum 1-hour ozone performance statistics in the WNNA for the 2012 ozone season (May - September).

Daily Maximum 1-hour ozone > 60 ppb with simulated data extracted at grid cell where the monitor is located	
Parameter	**WNNA**
Number of data points	57
Mean obs (ppb)	70.7
Standard Deviation obs (ppb)	6.7
Mean Bias (ppb)	-3.6
Mean Error (ppb)	6.5
RMSE (ppb)	8.6
Normalized Mean Bias (%)	-4.4
Normal Mean Error (%)	8.9
R-squared	0.05
Index of Agreement	0.53

Daily Maximum 1-hour ozone > 60 ppb with simulated data extracted from the 3x3 grid cell array maximum centered at the monitor	
Parameter	**WNNA**
Number of data points	63
Mean obs (ppb)	70
Standard Deviation obs (ppb)	8.7
Mean Bias (ppb)	-0.9
Mean Error (ppb)	5.9
RMSE (ppb)	7.7
Normalized Mean Bias (%)	-1.3
Normal Mean Error (%)	8.4
R-squared	0.1
Index of Agreement	0.6

Table 12. Hourly ozone performance statistics in the WNNA for the 2012 ozone season (May - September). Note that only statistics for the grid cell in which the monitor is located were calculated for hourly ozone.

Hourly ozone > 60 ppb with simulated data extracted at grid cell where the monitor is located	
Parameter	**WNNA**
Number of data points	209
Mean obs (ppb)	67.8
Standard Deviation obs (ppb)	5.6
Mean Bias (ppb)	-2.2
Mean Error (ppb)	5.2
RMSE (ppb)	6.8
Normalized Mean Bias (%)	-3.2
Normal Mean Error (%)	7.7
R-squared	0.04
Index of Agreement	0.52

Similarly, Shearer et al. (2012)[60] compared model performance in Central California during two episodes in 2000 (July 24 – 26 and July 31 – August 2) for two different chemical mechanisms and found that normalized bias for daily maximum 8-hour ozone ranged from -7% to -14% with hourly peak ozone showing a slightly larger range from -7% to -18%. These values are greater than the statistics found in this work, which were calculated as -6% (or -4.9 % with 3x3 maximum values) for daily maximum 8-hour ozone and -4.4% (or -1.3% with 3x3 maximum values) for daily maximum 1-hour ozone. Jin et al. (2010)[61] conducted a longer term simulation over Central California (summer 2000) and found a RMSE for daily maximum 8-hour ozone of 14 ppb, which is greater than the 7.4 ppb (or 7.4 ppb with 3x3 maximum values) found in this work. Jin et al. (2010) also showed an overall negative bias of -2 ppb, which is consistent with the -4.1 ppb (-3.4 ppb with 3x3 maximum values) found in this work.

Simon et al. (2012)[62] conducted a review of photochemical model performance statistics published between 2006 and 2012 for North America (from 69 peer-reviewed articles). In Figure 12, the statistical evaluation of this model attainment demonstration is compared to the model performance summary presented in Simon et al. (2012) by overlaying various summary statistics

[60] Shearer, S. M., Harley, R. A., Jin, L., and Brown, N. J.: Comparison of SAPRC99 and SAPRC07 mechanisms in photochemical modeling for central California, *Atmos. Environ.*, 46, 205-216, 2012.
[61] Jin, L., Brown, N. J., Harley, R. A., Bao, J.-W., Michelson, S. A., and Wilczak, J. M.: Seasonal versus episodic performance evaluation for an Eulerian photochemical air quality model, *J. Geophys. Res.*, 115, D09302, doi:10.1029/2009JD012680, 2010.
[62] Simon, H., Baker, K. R., and Phillips, S.: Compilation and interpretation of photochemical model performance statistics published between 2006 and 2012, *Atmospheric Environment*, 61, 124-139, 2012.

onto the Simon et al. (2012) model performance summary. Note that the box-and-whisker plot (colored in black) shown in Figure 12 is reproduced using data from Figure 4 of Simon et al. (2012). The blue dot and red triangle in each of the panels in Figure 12 denote the model performance statistics from the current modeling work, calculated using the simulated monitor grid cell and the 3x3 maximum, respectively.

Figure 12 clearly shows that the model performance statistical metrics for hourly, daily maximum 8-hour and daily maximum 1-hour ozone from this work are consistent with previous modeling studies reported in the scientific literature, and in most cases are better than those statistics. In particular, the Simon et. al. (2012) study found that mean bias for daily maximum 8-hour ozone ranged from approximately -7 ppb to 13 ppb, while mean error ranged from around 4 ppb to 22 ppb, and RMSE varied from approximately 8 ppb to 23 ppb; all of which are similar in magnitude to the statistics presented in Table 10.

Additional analysis, including time series, scatter plots, and frequency distribution of the hourly, 1-hour daily maximum and 8-hour average daily maximum ozone data used to generate Tables 10, 11 and 12 can be found in the supplementary material.

5.2.1 DIAGNOSITC EVALUATION

In addition to the statistical evaluation presented above, since the modeling is utilized in a relative sense, it is also useful to consider whether the model is able to reproduce observable relationships between changes in emissions and ozone. One approach to this would be to conduct a retrospective analysis where additional years are modeled (e.g., 2000 or 2005) and then investigate the ability of the modeling system to reproduce the observed changes in ozone over time. Since this approach is extremely time consuming and resource intensive, it is generally not feasible to perform such an analysis under the constraints of a typical SIP modeling application. An alternative approach for investigating the ozone response to changes in emissions is through the so called “weekend effect”.

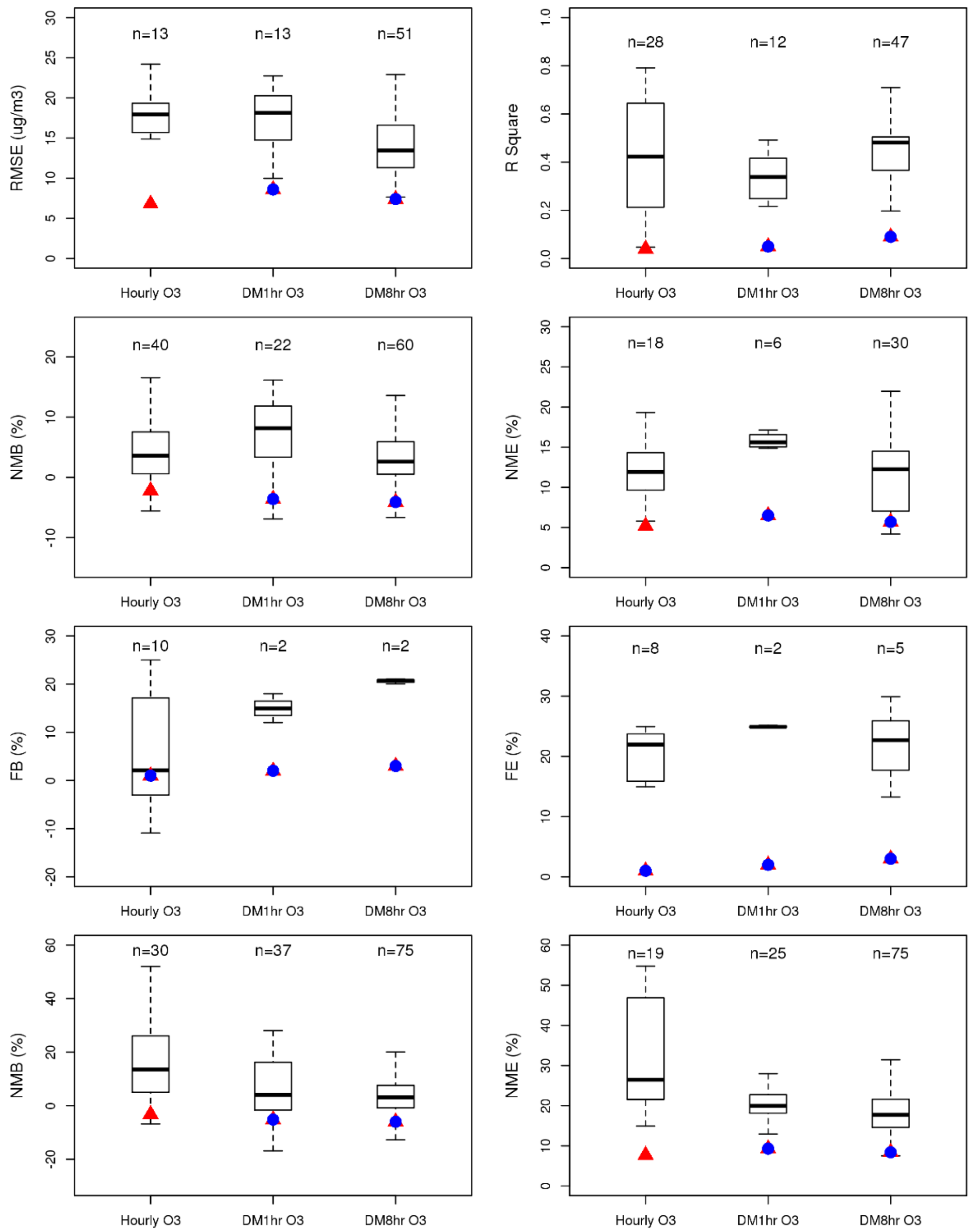


Figure 12. Comparison of various statistical metrics, from the model attainment demonstration modeling, to the range of statistics from the 69 peer-reviewed studies summarized in Simon et al. (2012)[63]. (MDA denotes Maximum Daily Average).

[63] Simon, H., Baker, K. R., and Phillips, S.: Compilation and interpretation of photochemical model performance statistics published between 2006 and 2012, *Atmospheric Environment*, 61, 124-139, 2012.

The so called “weekend effect” is a well-known phenomenon in some major urbanized areas where emissions of NO_x are substantially lower on weekends than on weekdays, but measured levels of ozone are higher on weekends than on weekdays. This is due to the complex and non-linear relationship between NO_x and ROG precursors and ozone (e.g., Sillman, 1999)[64].

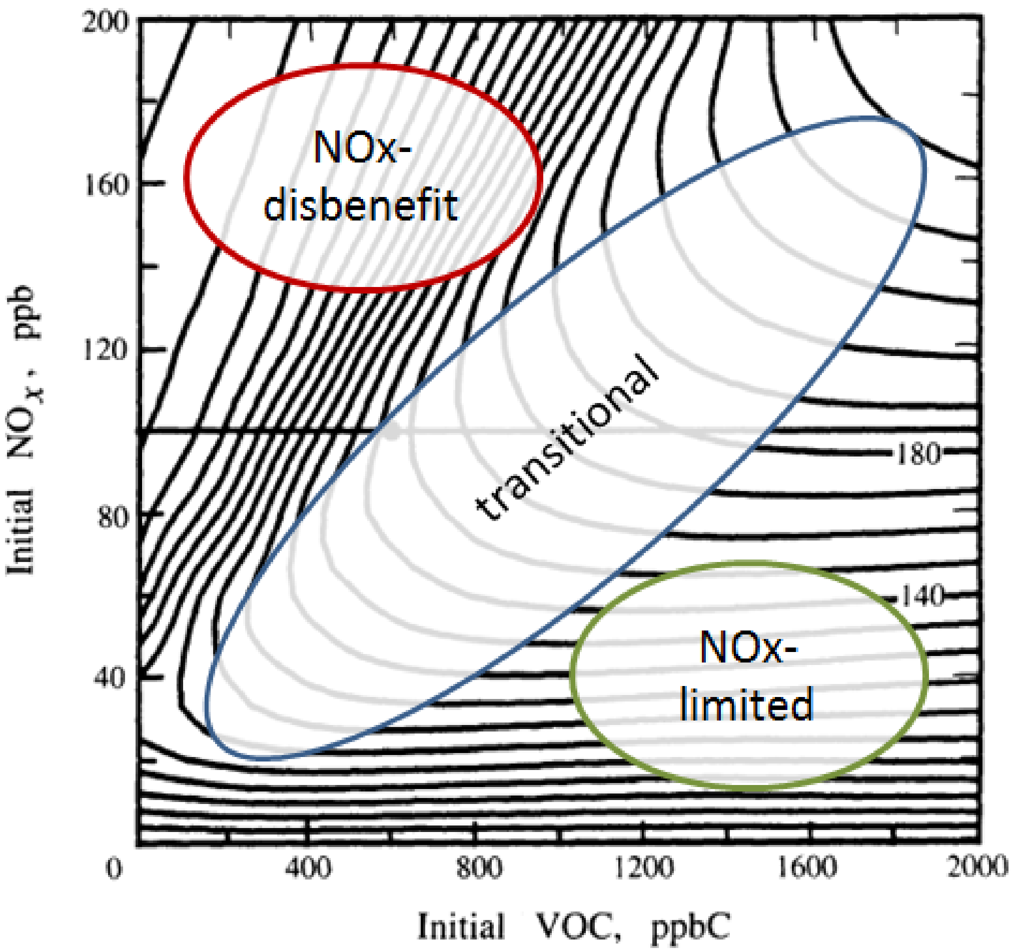


Figure 13. Illustrates a typical ozone isopleth plot, where each line represents ozone mixing ratio, in 10 ppb increments, as a function of initial NO_x and VOC (or ROG) mixing ratio (adapted from Seinfeld and Pandis, 1998[65], Figure 5.15). General chemical regimes for ozone formation are shown as NO_x-disbenefit (red circle), transitional (blue circle), and NO_x-limited (green circle). In general terms, under ambient conditions of high-NO_x and low-ROG (NO_x-disbenefit region in Figure 13), ozone formation tends to exhibit a disbenefit to reductions in NO_x emissions (i.e., ozone increases with decreases in NO_x) and a benefit to reductions in ROG emissions (i.e., ozone decreases with decreases in ROG). In contrast, under ambient conditions of low-NO_x and high-

---

[64] Sillman, S., 1999. The relation between ozone, NOx, and hydrocarbons in urban and rural polluted environments, *Atmospheric Environment*, 33, 1821-1845.
[65] Seinfeld J. H. and Pandis S. N. (1998) Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, 1st edition, J. Wiley, New York.

ROG (NO_x-limited region in Figure 13), ozone formation shows a benefit to reductions in NO_x emissions, while changes in ROG emissions result in only minor decreases in ozone. These two distinct "ozone chemical regimes" are illustrated in Figure 13 along with a transitional regime that can exhibit characteristics of both the NO_x-disbenefit and NOx-limited regimes. Note that Figure 13 is shown for illustrative purposes only, and does not represent the actual ozone sensitivity within the WNNA for a given combination of NO_x and ROG (VOC) emissions.

In this context, the prevalence of a weekend effect in a region suggests that the region is in a NO_x-disbenefit regime[66]. A lack of a weekend effect (i.e., no pronounced high O_3 occurrences during weekends) would suggest that the region is in a transition regime and moving between exhibiting a NO_x-disbenefit and being NO_x-limited. A reversed weekend effect (i.e., lower O_3 during weekends) would suggest that the region is NO_x-limited.

Investigating the "weekend effect" and how it has changed over time is a useful real world metric for evaluating the ozone chemistry regime in the WNNA and how well it is represented in the modeling. The trend in day-of-week dependence in the WNNA was analyzed using the ozone observations between 2000 and 2015 and the average site-specific weekday (Wednesday and Thursday) and weekend (Sunday) observed summertime (June through September) maximum daily average (MDA) 8-hour ozone values by year (2000 to 2015) are compared (Figure 14). Different definitions of weekday and weekend days were also investigated and did not show appreciable differences from the Wednesday/Thursday and Sunday definitions. A key observation in Figure 14 is that the summertime average weekday and weekend ozone levels have steadily declined between 2000 and 2015.

---

[66] Heuss, J.M., Kahlbaum, D.F., and Wolff, G.T., 2003. Weekday/weekend ozone differences: What can we learn from them? Journal of the Air & Waste Management Association 53(7), 772-788

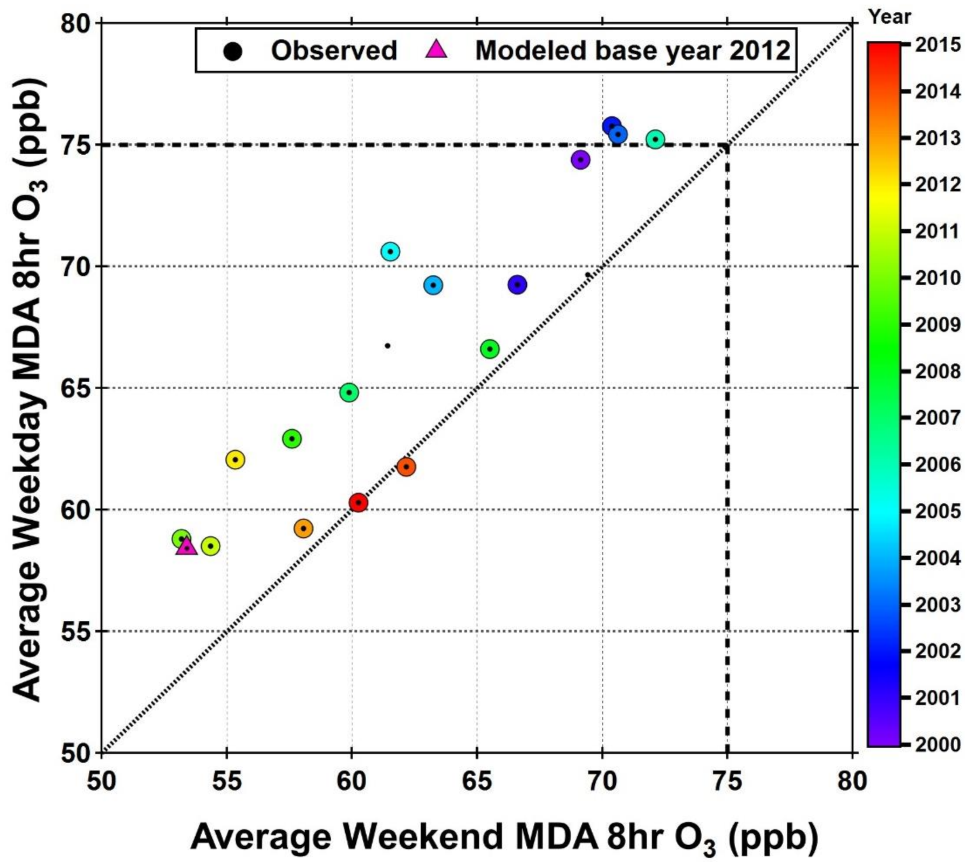


Figure 14. Site-specific average weekday and weekend maximum daily average 8-hour ozone for each year from 2000 to 2015 in the WNNA. The colored circle markers denote observed values while the magenta triangle markers denote the simulated baseline 2012 values. Points falling below the 1:1 dashed line represent a NO_x-disbenefit regime, those on the 1:1 dashed line represent a transitional regime, and those above the 1:1 dashed line represent a NO_x-limited regime.

Along with the declining ozone, it can be seen that the WNNA has been in a NO_x limited regime all along as seen from the greater weekday ozone when compared to the weekend ozone. This region is in close proximity to biogenic ROG emissions sources and farther away from the anthropogenic NO_x sources, such that low NO_x and high ROG reactivity conditions are prevalent, which is consistent with the region being in a NO_x-limited regime. The occasional shift in weekday/weekend ozone levels closer to the 1:1 dashed line (and in some years crossing over the line) is likely due to interannual variability in meteorological conditions and its impact on the regional transport patterns and local biogenic ROG emissions.

The simulated baseline 2012 weekday/weekend values (magenta triangle marker in Figure 14) from the attainment demonstration modeling show greater weekday ozone compared to weekend ozone in the WNNA. These predicted values are consistent with observed findings in 2012 that show a prevalence of NO_x-limited conditions in the WNNA.

5.3. RELATIVE RESPONSE FACTORS AND FUTURE YEAR DESIGN VALUES

The RRFs (Section 2.5) and future year design values (Section 2.6) for the Grass Valley-Litton Building site in the WNNA were calculated using the procedures outlined in the corresponding sections, respectively, and are summarized in Table 13. The Grass Valley-Litton Building site has a base year DV of 79 ppb, which is projected to decrease to 67 ppb in 2020, which supports attainment of the 75 ppb standard in 2020.

Table 13. Summary of key parameters related to the calculation of future year 2020 8-hour ozone design values (DV) at the Grass Valley-Litton Building monitoring site in the WNNA. Note that final future year DVs are truncated, and fractional values are shown for reference only.

Site Location	Base year Average DV (ppb)	Future Year 2020	
		RRF	Average DV (ppb)
Grass Valley-Litton Building	79.0	0.8571	67.7

5.4. 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[67]). U.S. EPA recommends combining spatially interpolated design value fields with modeled ozone gradients and grid-specific RRFs in order to generate gridded future year gradient adjusted design values.

This analysis can be done using the Model Attainment Test Software (MATS) (Abt, 2014[68]). 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[69] developed at ARB, were utilized in this analysis.

The unmonitored area analysis was conducted using the 8-hr O_3 weighted DVs from all the available sites that fall within the 4 km inner modeling domain along with the reference year 2012 and future year 2020 4 km CMAQ model output. The steps followed in the unmonitored area analysis are as follows:

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

[68] Abt, 2014. Modeled Attainment Test Software: User's Manual. MATS available at: http://www.epa.gov/scram001/modelingapps_mats.htm

[69]The R Project for Statistical Computing available at https://www.r-project.org/

Step 1: At each grid cell, the top 10 modeled maximum daily average 8-hour ozone mixing ratios from the reference year simulation were averaged, and a gradient in this top 10 day average between each grid cell and grid cells which contain a monitor was calculated.

Step 2: A single set of spatially interpolated 8-hour ozone DV fields was generated based on the observed 5-year weighted base year 8-hour 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[70], 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 5.3, except that the +/- 20% limitation on the simulated and observed maximum daily average 8-hour ozone was not applied because observed data do not exist for grid cells in unmonitored areas.

Step 4: The future year gridded 8-hour ozone DVs were calculated by multiplying the gradient-adjusted interpolated 8-hour ozone DVs from Step 2 with the gridded RRFs from Step 3

Step 5: The future-year gridded 8-hour ozone DVs (from Step 4) were examined to determine if there are any peak values higher than those at the monitors, which could potentially cause violations of the applicable 8-hour ozone NAAQS.

Figure 15 shows the spatial distribution of gridded DVs in 2020 for the WNNA based on the unmonitored area analysis (described above). The black colored triangle markers denote the monitoring sites, which had valid reference year DVs and were used in the analysis. The unmonitored area analysis in the WNNA showed that all the areas in the non-attainment area have future year 2020 DVs less than 75 ppb.

[70] R tripack library available at https://cran.r-project.org/web/packages/tripack/README)

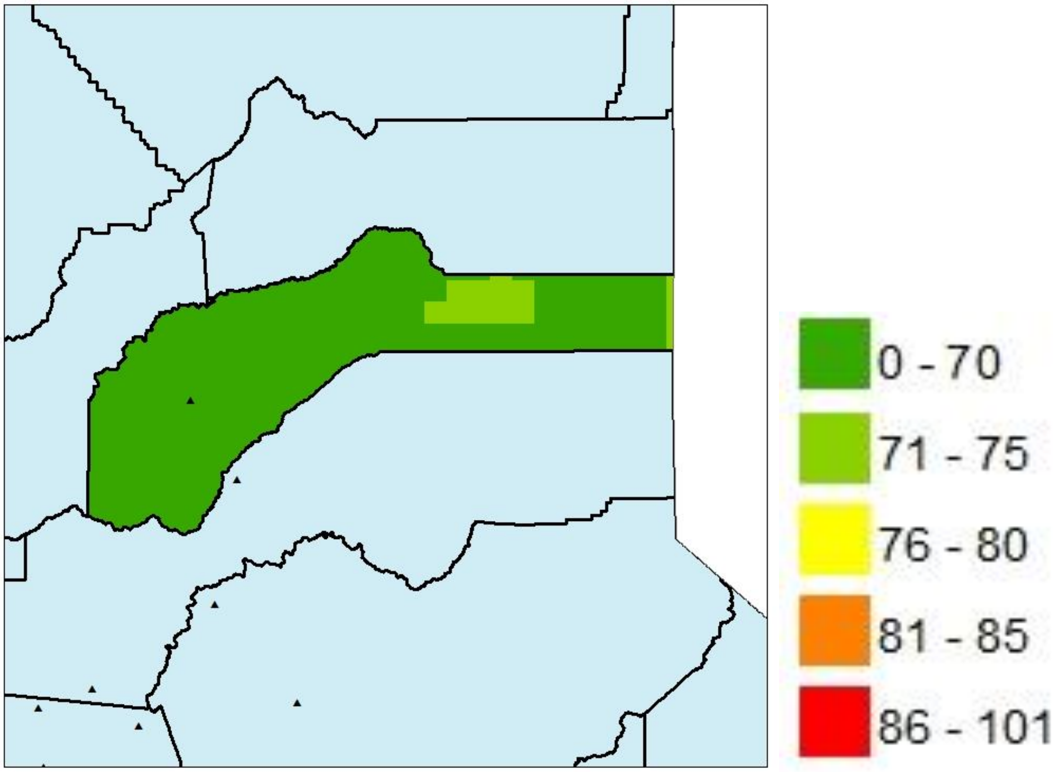


Figure 15. Spatial distribution of the future 2020 DVs based on the unmonitored area analysis in the WNNA. Color scale is in ppb of ozone.

SUPPLEMENTAL MATERIALS

SUPPLEMENTAL MATERIALS TABLE OF CONTENTS

METEROLOGICAL TIME SERIES AND MEAN BIAS/ERROR DISTRIBUTION PLOTS 47

OZONE PLOTS 55

SUPPLEMENTAL MATERIALS LIST OF FIGURES

Figure S. 1 Time series of average wind speed, direction, and temperature of all sites in May 2012. 48
Figure S. 2 Time series of average wind speed, direction, and temperature of all sites in June 2012. 49
Figure S. 3 Time series of average wind speed, direction, and temperature of all sites in July 2012. 50
Figure S. 4 Time series of average wind speed, direction, and temperature of all sites in August 2012. 51
Figure S. 5 Time series of average wind speed, direction, and temperature of all sites in September 2012. 52
Figure S. 6 Wind speed mean bias for May-September, 2012 53
Figure S. 7 Wind speed mean error for May-September, 2012 53
Figure S. 8 Temperature mean bias for May-September, 2012 54
Figure S. 9 Temperature mean error for May-September, 2012 54
Figure S. 10 Relative humidity mean bias for May-September, 2012 55
Figure S. 11 Relative humidity mean error for May-September, 2012 55
Figure S. 12 Observed and modeled ozone frequency distribution for the ozone season at the Grass Valley-Litton Building site (May – September, 2012) 56
Figure S. 13 Ozone Mean Bias Distribution for the ozone season at the Grass Valley-Litton Building site (May-September 2012) 57
Figure S. 14 Time-series of hourly ozone at the Grass Valley-Litton Building site for the ozone season (May-September 2012) 58
Figure S. 15 Time-series of daily maximum 1-hour ozone at Grass Valley-Litton Building site for the ozone season (May-September 2012) 59
Figure S. 16 Time-series of daily maximum average 8-hour ozone at the Grass Valley-Litton Building site for the ozone season (May-September 2012) 59

METEROLOGICAL TIME SERIES AND MEAN BIAS/ERROR DISTRIBUTION PLOTS

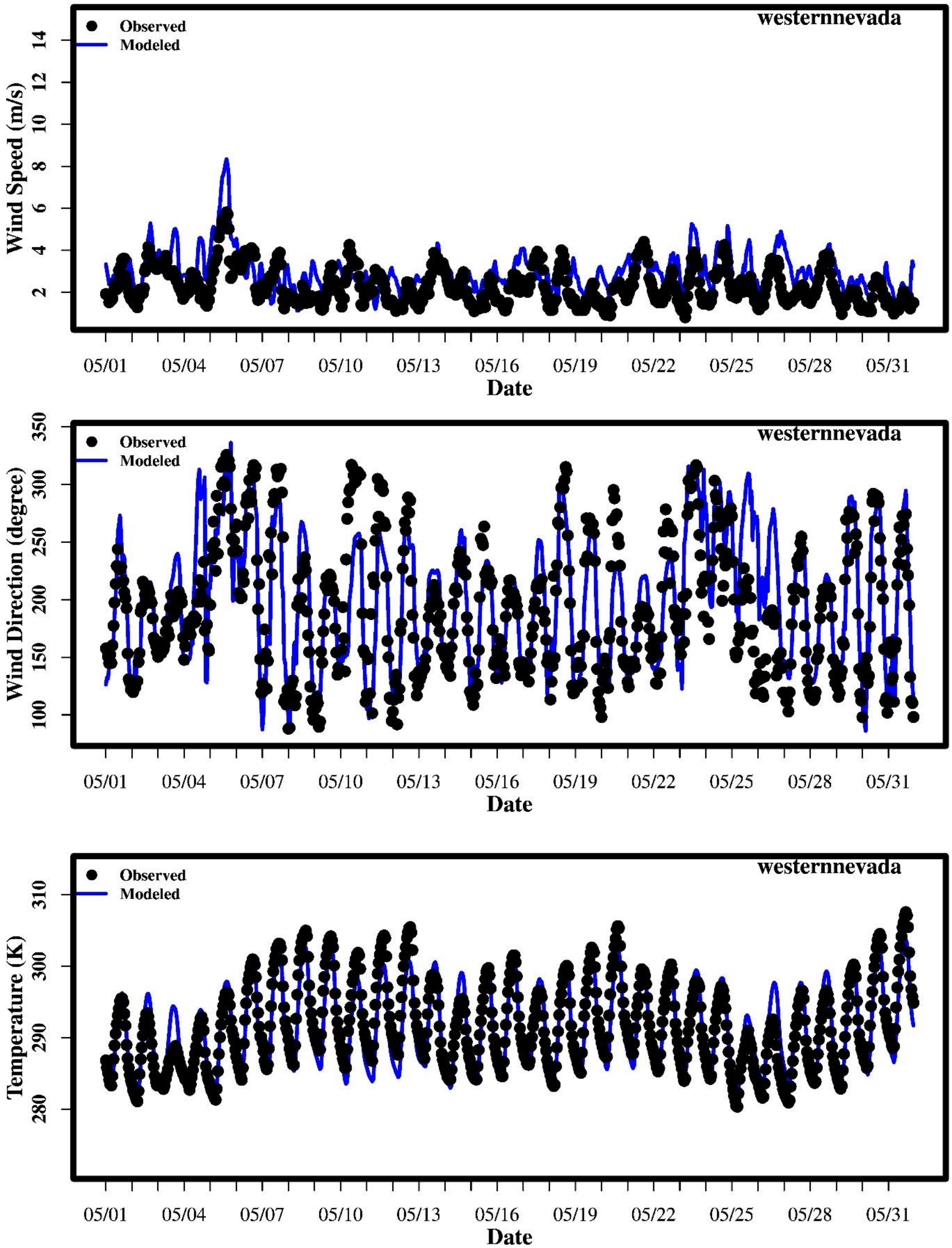


Figure S. 1 Time series of average wind speed, direction, and temperature of all sites in May 2012.

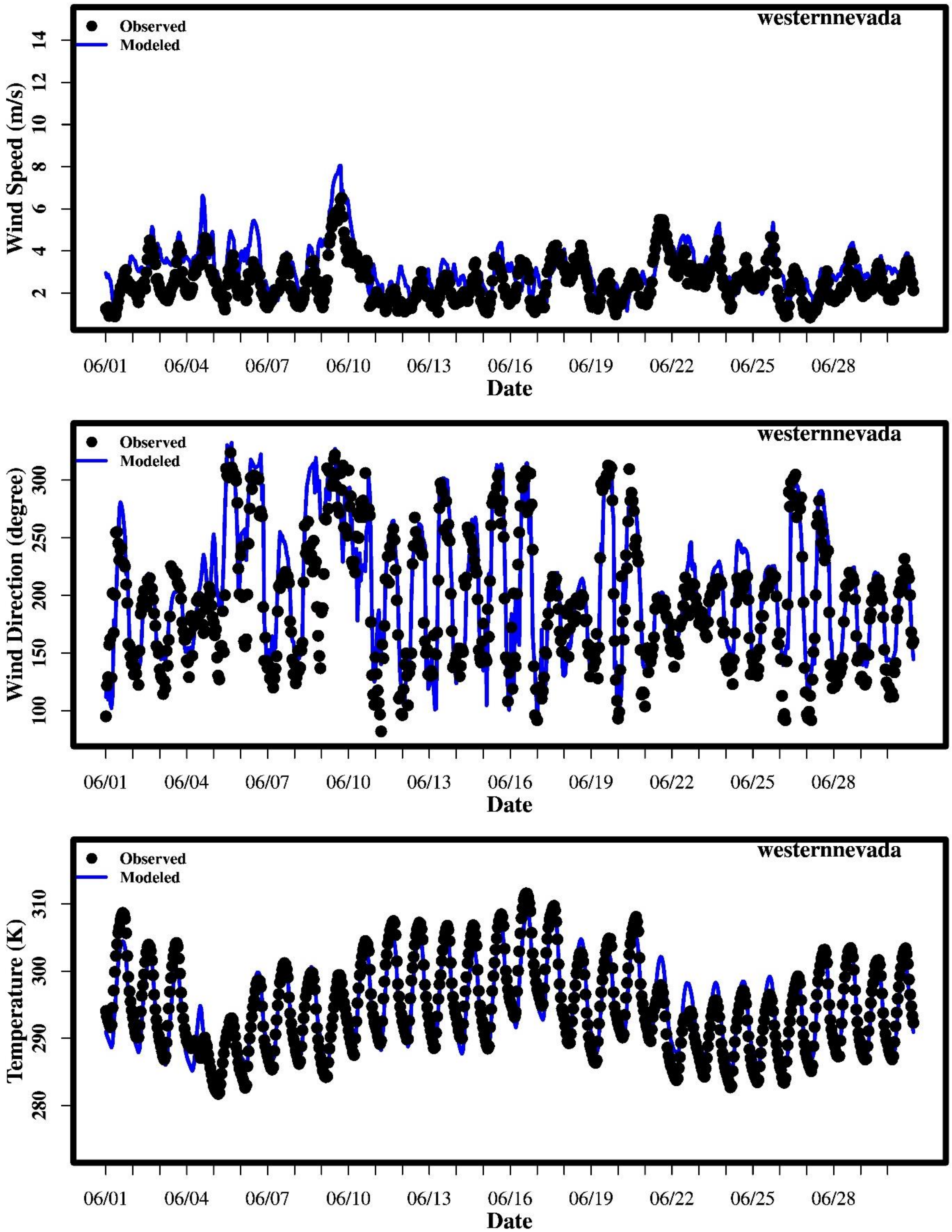


Figure S. 2 Time series of average wind speed, direction, and temperature of all sites in June 2012.

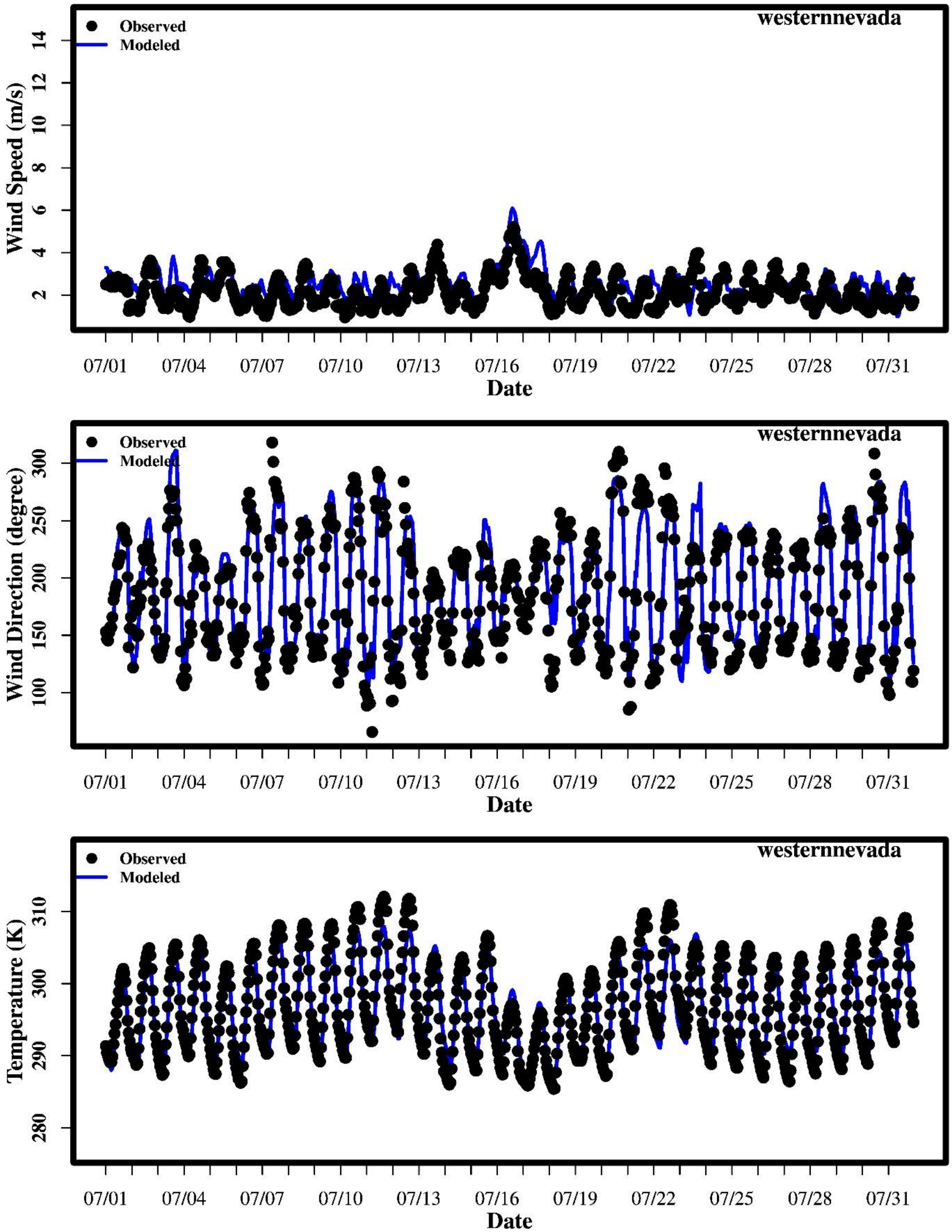


Figure S. 3 Time series of average wind speed, direction, and temperature of all sites in July 2012.

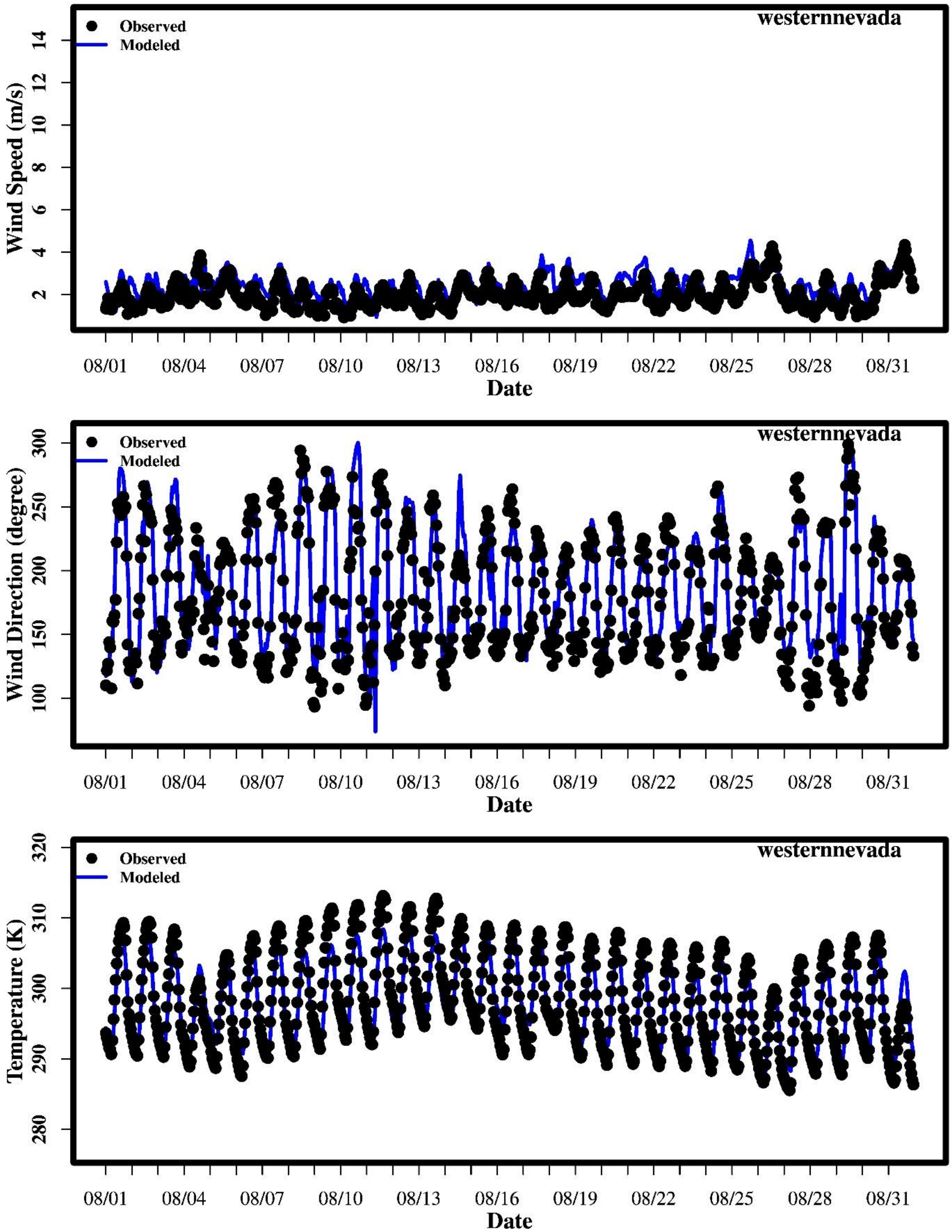


Figure S. 4 Time series of average wind speed, direction, and temperature of all sites in August 2012.

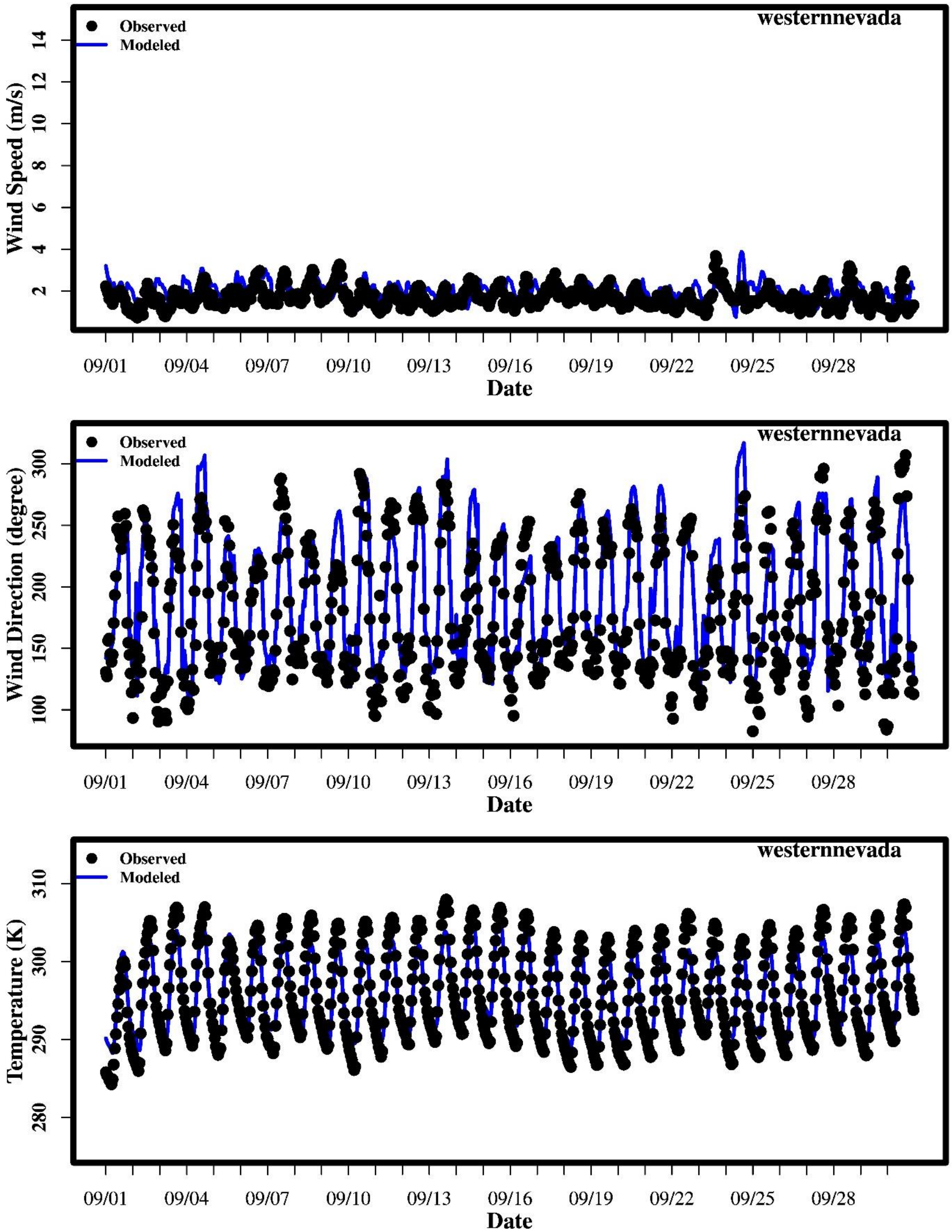


Figure S. 5 Time series of average wind speed, direction, and temperature of all sites in September 2012.

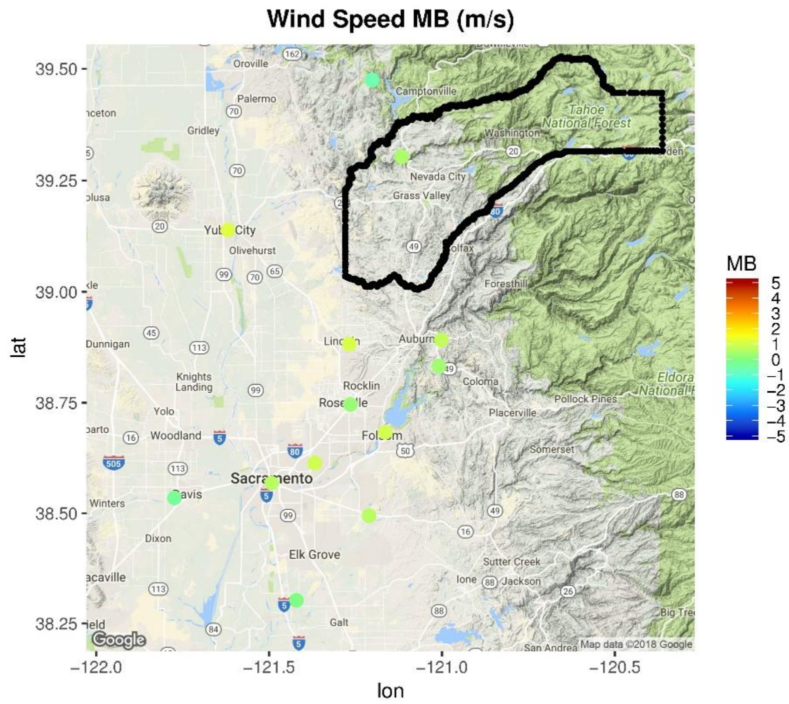


Figure S. 6 Wind speed mean bias for May-September, 2012

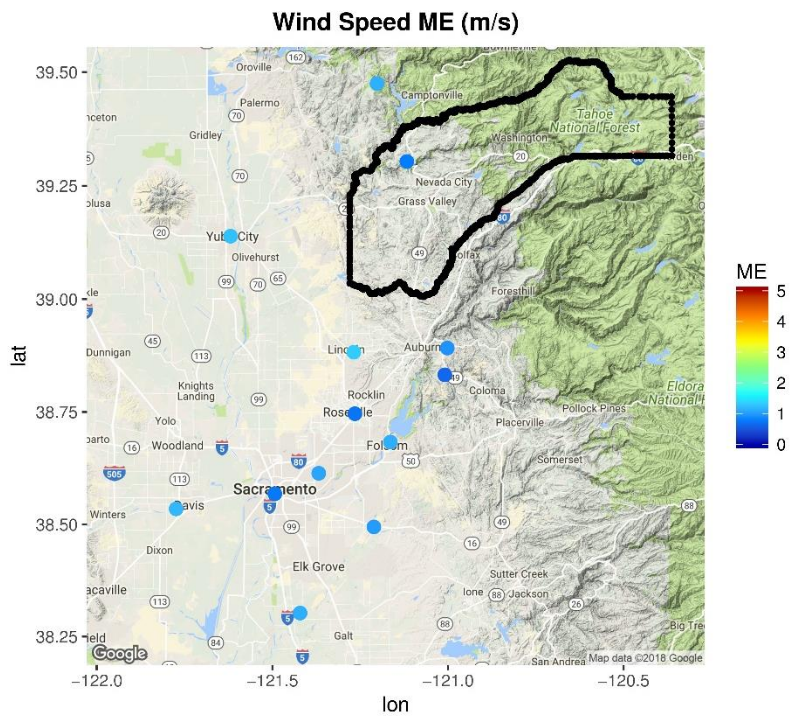


Figure S. 7 Wind speed mean error for May-September, 2012

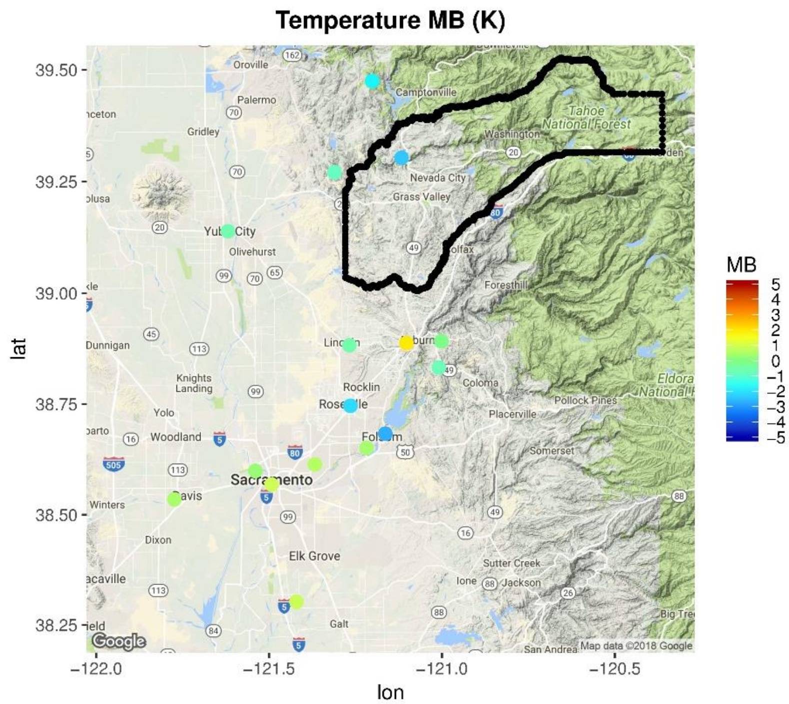


Figure S. 8 Temperature mean bias for May-September, 2012

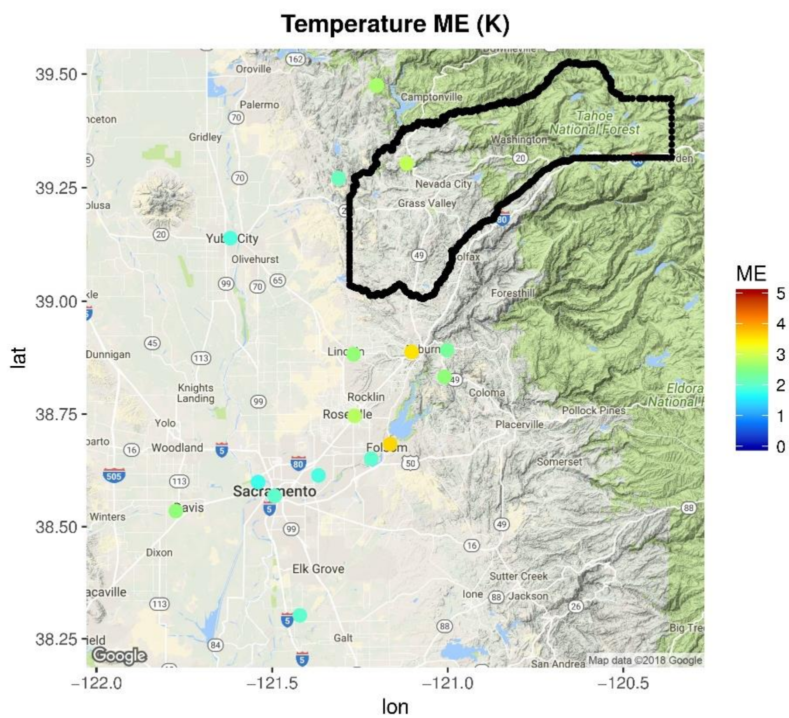


Figure S. 9 Temperature mean error for May-September, 2012

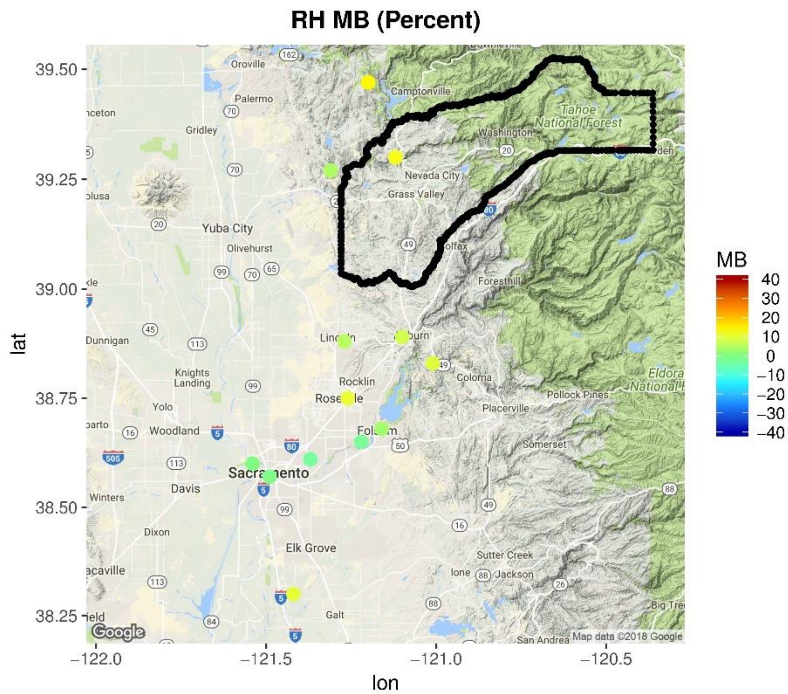


Figure S. 10 Relative humidity mean bias for May-September, 2012

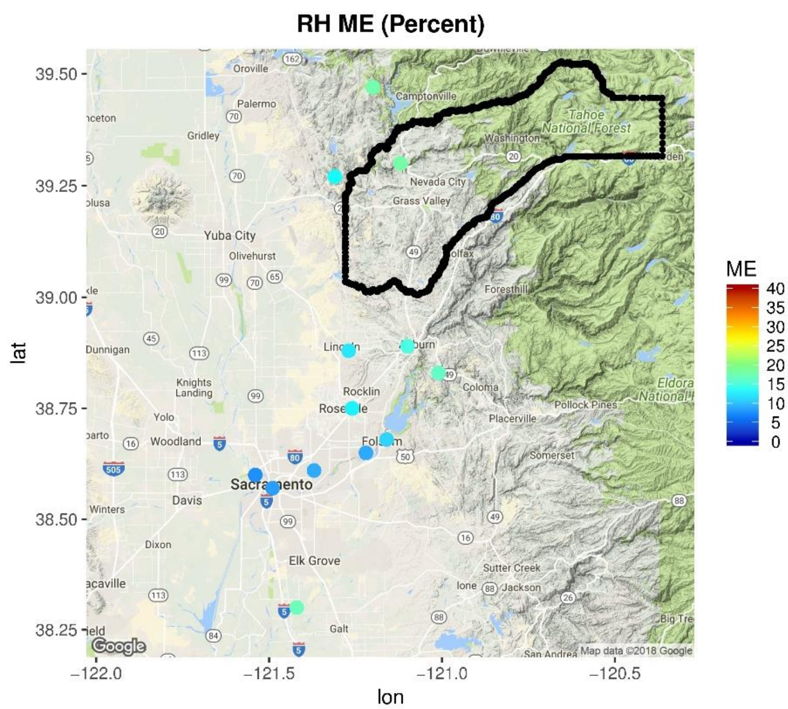


Figure S. 11 Relative humidity mean error for May-September, 2012

OZONE PLOTS

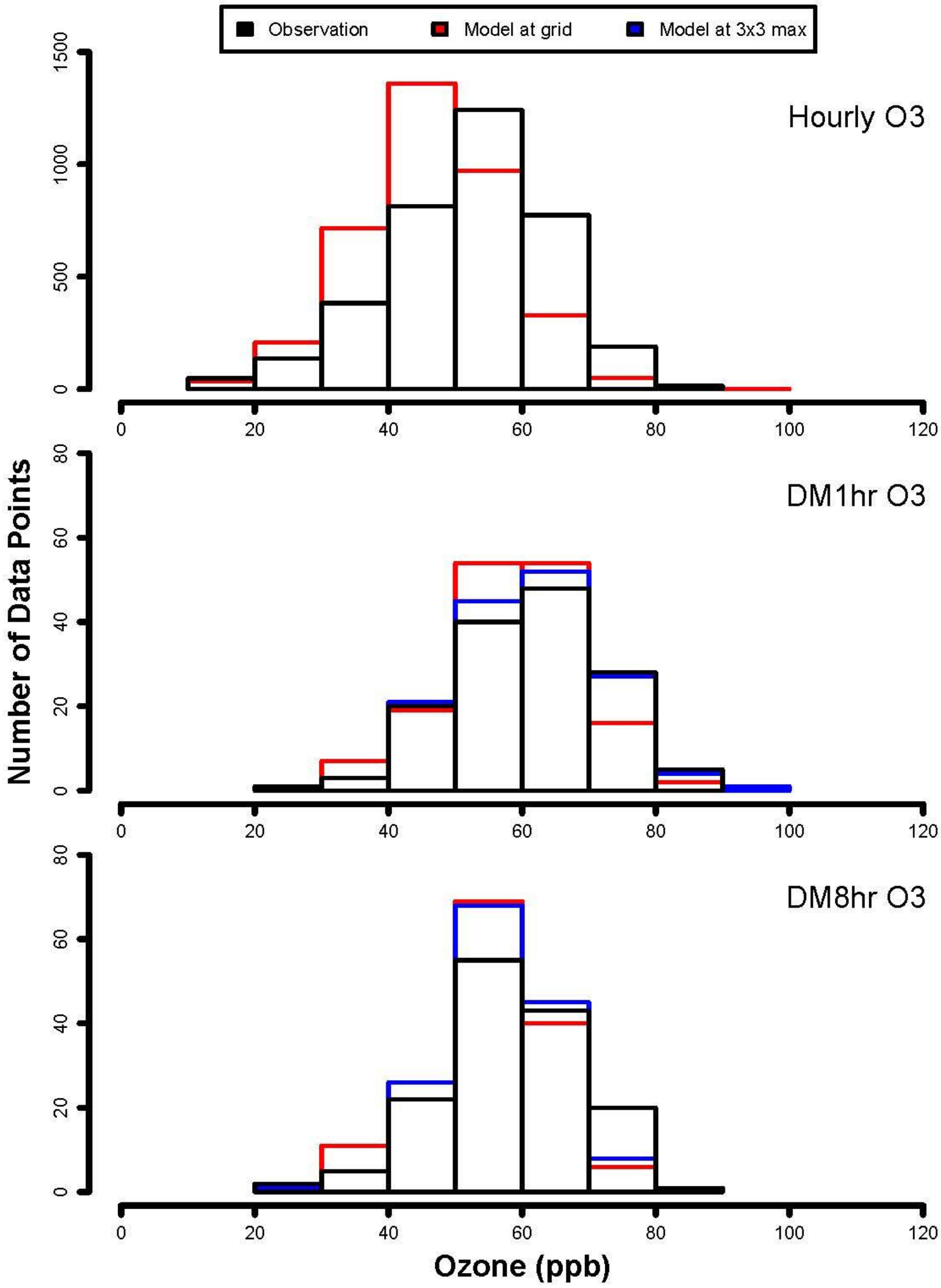


Figure S. 12 Observed and modeled ozone frequency distribution for the ozone season at the Grass Valley-Litton Building site (May – September, 2012)

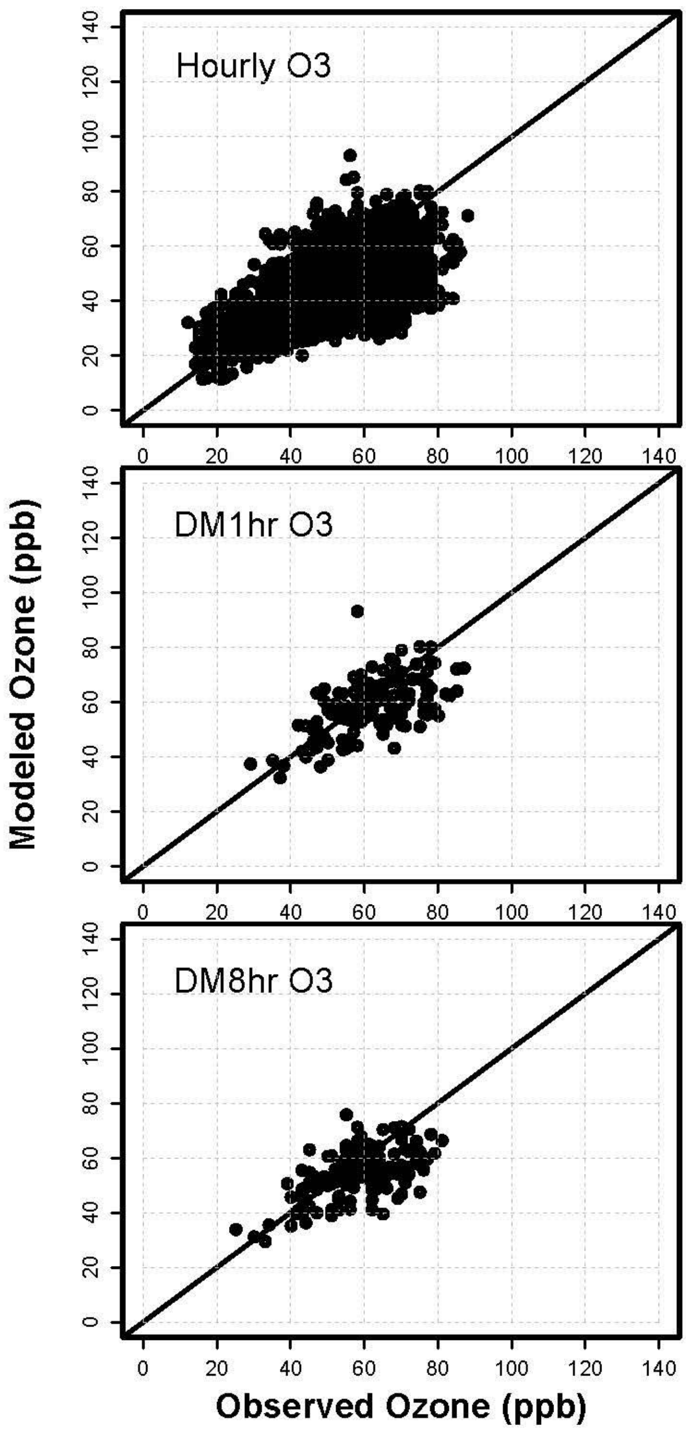


Figure S. 13 Ozone Mean Bias Distribution for the ozone season at the Grass Valley-Litton Building site (May-September 2012)

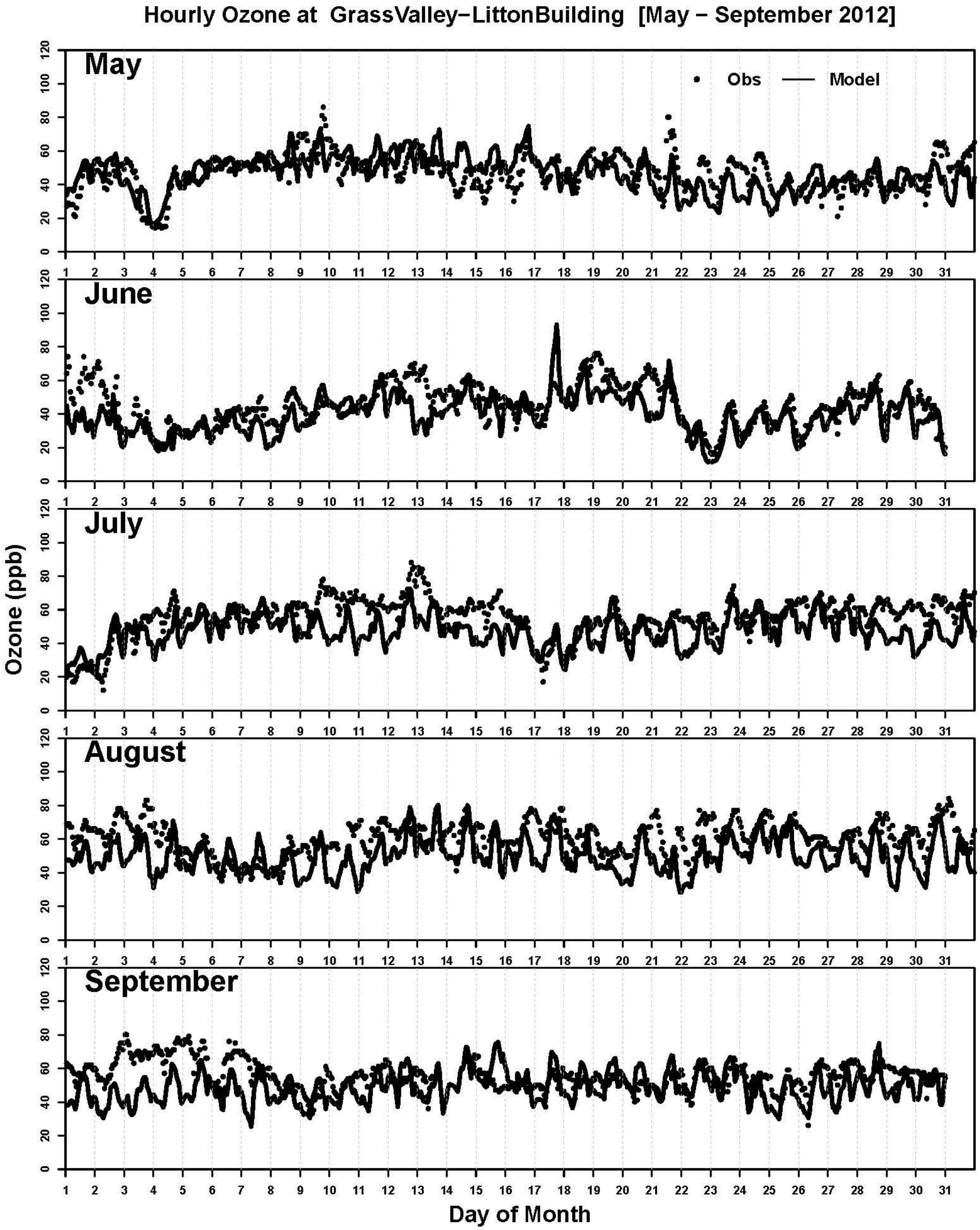


Figure S. 14 Time-series of hourly ozone at the Grass Valley-Litton Building site for the ozone season (May-September 2012)

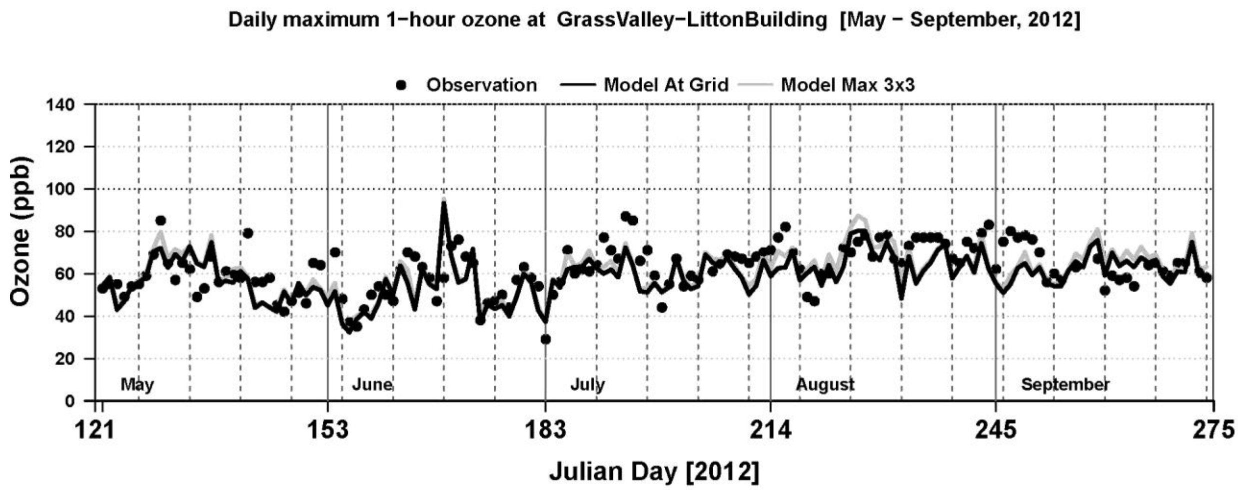


Figure S. 15 Time-series of daily maximum 1-hour ozone at Grass Valley-Litton Building site for the ozone season (May-September 2012)

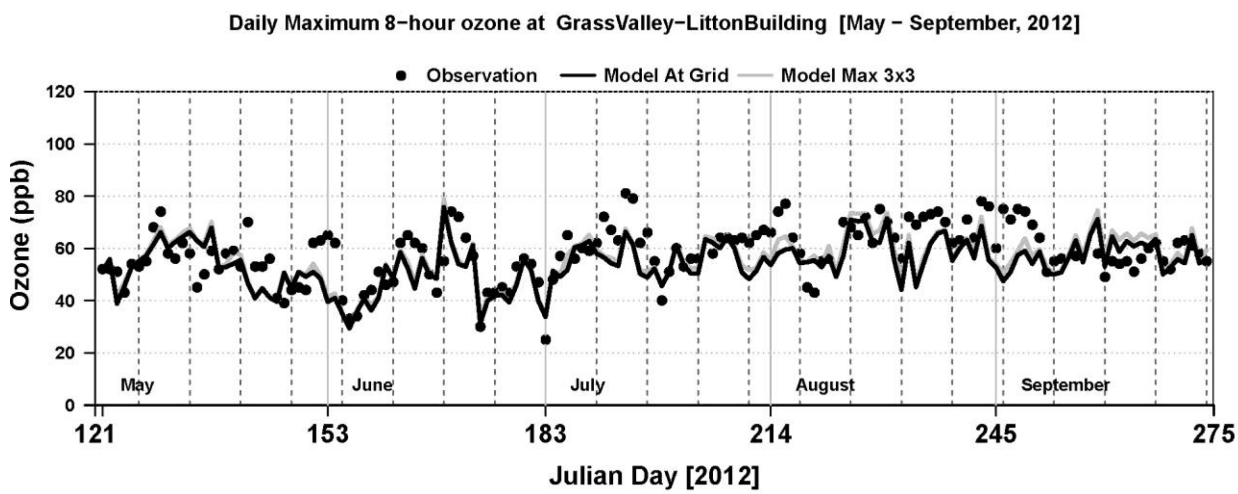


Figure S. 16 Time-series of daily maximum average 8-hour ozone at the Grass Valley-Litton Building site for the ozone season (May-September 2012)

Appendix F

Modeling Emission Inventory for the 8-Hour Ozone

State Implementation Plan in Western Nevada County

Non-attainment Area (WNNA)

Modeling Emission Inventory for the 8-Hour Ozone State Implementation Plan in Western Nevada County Non-attainment Area (WNNA)

Prepared by

California Air Resources Board

Northern Sierra Air Quality Management District

Prepared for

United States Environmental Protection Agency Region IX

September 1, 2018

Table of Contents

1. Development of Ozone Emissions Inventories 5

1.1. Inventory Coordination 6

1.2. Background 6

1.3. Inventory Years 7

1.3.1. Base Case Modeling Inventory (2012) 8

1.3.2. Reference Year Modeling Inventory (2012) 8

1.3.3. Future Year Modeling Inventory (2020) 8

1.4. Spatial Extent of Emission Inventories 9

2. Estimation of Base Year Modeling Inventory 11

2.1. Terminology 11

2.2. Temporal Distribution of Emissions 12

2.2.1. Monthly Variation 13

2.2.2. Weekly Variation 13

2.2.3. Daily Variation 14

2.3. Spatial Allocation 16

2.3.1. Spatial Allocation of Area Sources 19

2.3.2. Spatial Allocation of Point Sources 19

2.3.3. Spatial Allocation of Wildfires, Prescribed Burns and Wildland Fire Use 19

2.3.4. Spatial Allocation of Ocean Going Vessels (OGV) 20

2.3.5. Spatial Allocation of On-road Motor Vehicles 20

2.3.6. Spatial Allocation of Biogenic Emissions 20

2.4. Speciation Profiles 20

3. Methodology for Developing Baseline Year Emissions Inventory 22

3.1. Surface Temperature and Relative Humidity Fields 22

3.2. Insolation Effects 23

3.3. Estimation of Gridded Area and Point sources 24

3.4. Estimation of On-road Motor Vehicle Emissions 24

3.4.1. General Methodology 25

3.4.2. Integrated Transportation Network (ITN) Activity Data 27

3.4.3. Spatial Adjustment 29

3.4.4. Temporal Adjustment (Day-of-Week adjustments to EMFAC daily totals) 32

3.4.5. Temporal Adjustment (Hour-of-Day re-distribution of hourly travel network volumes) 33
3.4.6. Summary of On-road Emissions Processing Steps 33
3.5. Estimation of Gridded Biogenic Emissions 35
3.6. Estimation of Other Day-Specific Sources 35
3.6.1. Wildfires and Prescribed Burns 36
3.6.2. Paved Road Dust 37
3.6.3. Unpaved Road Dust 37
3.6.4. Agricultural Burning 38
3.6.5. Refinery Fire 40
3.6.6. Closed Facilities 41
3.7. Application of Control Measure Reduction Factors in Western Nevada county 41
4. Quality Assurance of Modeling Inventories 42
4.1. Area and Point Sources 42
4.1.1. Area and Point Sources Temporal Profiles 44
4.2. On-road Emissions 44
4.3. Day-specific Sources 45
4.3.1. Wildfires and Prescribed Burns 45
4.3.2. Paved Road Dust 46
4.3.3. Unpaved Road Dust 46
4.3.4. Agricultural Burning 46
4.3.5. Chevron Refinery Fire 46
4.4. Additional QA 46
4.5. Model ready files QA 49
Bibliography 50
Appendix A: Day of week redistribution factors by vehicle type and county 55
Appendix B: Hour of Day Profiles by vehicle type and county 60
Appendix C: Scaling procedures after DTIM processing 90
Appendix D: Additional temporal profiles 92

Figure 1 Spatial coverage and parameter summary of modeling domains 9
Figure 2 Block diagram for on-road processing 26
Figure 3 Example of a spatial plot by source category.......................................43
Figure 4 Screen capture of a SMOKE-generated QA report.............................44
Figure 5 Screenshot of comparison of inventories report..................................48
Figure 6 Daily variation of NOx emissions for mobile sources for San Luis Obispo 49

Table 1 Modeling domain parameters...10
Table 2 Inventory terms for emission source types..12
Table 3 Day of week variation factors 14
Table 4 Daily variation factors...15
Table 5 Spatial Surrogates 17
Table 6 Vintage of travel demand models for link based and traffic analysis zone 28
Table 7 DTIM Emission Categories 31
Table 8 Vehicle classification and type of adjustment.......................................32
Table 9 Day of week adjustment by vehicle class and county 55
Table 10 Hour of Day Profiles by vehicle type and county................................60
Table 11 Day of week temporal profiles from the Agricultural Emissions Temporal and Spatial Allocation Tool (AgTool)..92
Table 12 Daily temporal profiles from the Agricultural Emissions Temporal and Spatial Allocation Tool (AgTool)..94

1. Development of Ozone Emissions Inventories

Emission inputs for air quality modeling (commonly and interchangeably referred to as ‘modeling inventories’ or ‘gridded inventories’) have been developed by CARB and district staff. These inventories support the different SIPs across California to meet various federal ozone 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 photochemical models.

The following sections of this document describe how base and future year 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 met every four to six weeks from March 2013 to May 2016 (ARB, 2016) . 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 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 (Jackson, 2012) 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 2.4. Additional information on CARB emission inventories can be found at: http://www.arb.ca.gov/ei/ei.htm.

1.3. Inventory Years

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 factor (RRF) used to project air quality to future years, the terms used in the preparation of the emission inventory scenarios must be clearly defined. In this document the following inventory definitions will be used:

1.3.1. Base Case Modeling Inventory (2012)

Base case modeling is intended to demonstrate confidence in the modeling system used for the modeled attainment test. The base case modeling inventory is not used as part of the modeled attainment test itself. Model performance is assessed relative to how well model-simulated concentrations match actual measured concentrations. The modeling inputs are developed to represent (as best as possible) actual, day-specific conditions. Therefore, the base case modeling inventory for 2012 includes day-specific emissions for certain sectors. This includes, for instance, actual district-reported point source emissions information for 2012, as well as other available day-specific activities and emission adjustments. The year 2012 was selected to coincide with the year selected for baseline design values (described below). The U.S. EPA modeling guidance states that once the model has been shown to perform adequately, the use of day-specific emissions is no longer needed. In preparation for SIP development, both CARB and the local air districts began a comprehensive review and update of the emission inventory several years ago resulting in the most up-to-date emissions inventory for 2012.

1.3.2. Reference Year 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. U.S. EPA modeling guidance describes the reference year modeling inventory as "a common starting point" that represents average or "typical" conditions that are consistent with the baseline design value period. U.S. EPA guidance also states "using a 'typical' or average reference year inventory provides an appropriate platform for comparisons between baseline and future years." 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, and district-reported point source emissions for 2012.

1.3.3. Future Year Modeling Inventory (2020)

Future year modeling inventories, along with the reference year modeling inventory, are used in the model-derived RRF calculation. Projected inventory years were chosen to address the following standards:

- 2020 is the modeled attainment year for the 8-hour (2008) Ozone standard of 75 ppb

This reflects the date by which attainment can be achieved as expeditiously as practicable for the relevant O_3 standard.

This inventory maintains the "typical", average patterns of the 2012 reference year modeling inventory. The 2020 inventory includes temperature, relative humidity, and solar insolation effects from reference year (2012) meteorology. Future year point and area source emissions are projected from the 2012 baseline emissions used in the 2012 reference year modeling inventory. Additionally, a future year 2020 on-road emission inventory is used, as projected by the latest EPA approved version of EMFAC2014. The application of control measure reduction factors is discussed in section 3.7.

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 16.

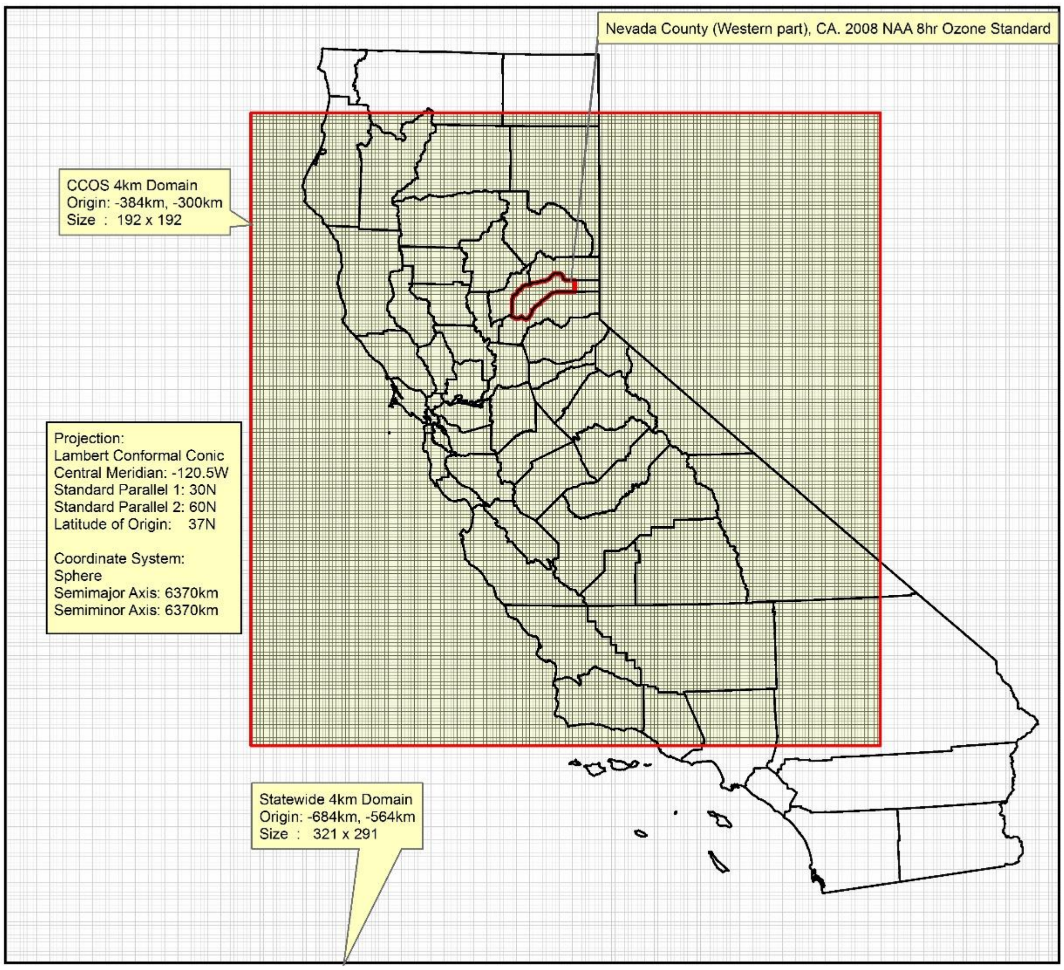


Figure 16 Spatial coverage and parameter summary of modeling domains

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 (ST4K) extends entirely over California and 100 nautical miles west over the Pacific Ocean. A smaller subdomain (Northern California or CCOS domain) is used for air quality modeling in Western Nevada County Non-attainment Area. It has the same grid definitions and resolution as the main domain, but has a smaller area to cover central California, northern California and a portion of the state of Nevada. The specifications of the emissions inventory domain and CCOS subdomain are summarized in Table 14.

Table 14 Modeling domain parameters

Parameter	Statewide domain (ST4K)	Subdomain (CCOS)
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	192 x 192 cells
Lambert origin	(-684,000 m, -564,000 m)	(-384,000 m, -300,000 m)
Geographic center	-120.5° Lat and 37.0° Lon	-120.5° Lat and 37.0° Lon

2. Estimation of Base Year Modeling Inventory

As mentioned in section 1.3, base case modeling is intended to demonstrate confidence in the modeling system used for the modeled attainment test. The following sections describe the temporal and spatial distribution of emissions and how the different sectors of this baseline year modeling inventory 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 15 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 a plume rise. While the current inventory includes emissions from stacks, all emission sources reported by the Northern Sierra Air Quality Management District (AQMD) and other local air districts 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 15 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

The emissions are temporally resolved by month, week, day and hour to more accurately gauge model performance and, ultimately, better assess the influence of control measures on attainment. This section covers the temporal distributions of the point, area, and off-road mobile sources. The temporal distribution of the on-road and biogenic emissions are discussed in Sections 3.4 and 3.5 respectively. Section 3.6 describes the temporal estimation of other day specific sources such as wildfires and agricultural burning. 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 assign 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 over 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 activity for each process, the sum of the relative activity for a year is 100. If the activity of a process is the same month to month, a monthly fraction is 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 ratio of a specific month's activity to the flat monthly profile. In the case of the flat monthly profile, 8.33, the emissions for a day in each month of the year remain unchanged. On the other hand, a typical monthly throughput in July for recreational boats is 15. The emissions for a typical day in July would be about 1.8 times higher than an annual average day (ratio of 15 / 8.33).

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 during weekdays. Other emissions sources may operate all week, but with a distinct difference in weekends and weekdays, 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 16 below shows the current DPWK codes and Table 24 in Appendix D shows additional DPWK codes used for agricultural related emissions.

Table 16 Day of week variation factors

Code	WEEKLY CYCLE CODE DESCRIPTION	M	T	W	TH	F	S	S
1	One day per week	1	0	0	0	0	0	0
2	Two days per week	1	1	0	0	0	0	0
3	Three days per week	1	1	1	0	0	0	0
4	Four days per week	1	1	1	1	0	0	0
5	Five days per week - Uniform activity on week days; none on Saturday and Sunday	1	1	1	1	1	0	0
6	Six days per week - Uniform activity on week days and Saturday; none on 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; Reduced activity on weekdays	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 on-road 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; one third as much 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. **Error! Reference source not found.** below shows the daily variation factors o r current HPDY codes. Table 25 in Appendix D shows additional DPWK codes used for agricultural-related emissions.

Table 17 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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	2 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	3 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	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	0	0	0	0	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	0	0	0	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	0	0	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	0	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 base case, reference or future year inventories are 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.

Three basic types of surrogate data were used to develop the 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 both baseline and future years. 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 (Standard Industrial Classification). Fourteen new surrogates were developed for industrial-related sources using SIC and whether manufacturing occurred at the facility.
- 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 ARB Equipment Registration database 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 18.

Table 18 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

Surrogate Name	Surrogate Definition
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
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
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-specific 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 Wildfires, Prescribed Burns and Wildland Fire Use

Emissions from these sources are event and location-based. A fire event can last a few hours or span multiple days. Each fire is spatially allocated to grid cells using the extent of each fire event, while the temporal distribution also reflects the actual duration of the fire. The spatial information to allocate the fire emissions comes from a statewide interagency fire perimeters geodatabase maintained by the Fire and Resource Assessment Program (FRAP) of the California Department of Forestry and Fire Protection (CALFIRE). More details on the methodology and estimation of the wildfire emissions can be found in Section 3.6.1.

2.3.4. 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: 1.) National Waterway Network, 2.) The Ship Traffic and 3.) Energy and Environment Model Automated instrumentation system (AIS) telemetry data collected in 2007.

2.3.5. 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.

2.3.6. Spatial Allocation of Biogenic Emissions

As described in section 3.5, the spatial allocation of biogenic emissions is accomplished using the Model of Emissions of Gases and Aerosols from Nature (MEGAN). More details can be found at: http://lar.wsu.edu/megan/. Driving variables in MEGAN include land cover, weather, and atmospheric chemical composition. MEGAN is set up to create 2D gridded emissions files at a resolution that matches the statewide 4k modeling domain.

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 CARB'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 CARB'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 the 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 Baseline Year Emissions Inventory

As mentioned in section 1, 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 year inventory is created for different sectors of the inventory such as 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 in 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 16 and Table 17**Error! Reference source not found.** are reformatted into an input-ready format as explained in the SMOKE user's manual. Chemical speciation profiles, as described in section 2.4, 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 17. Activity data from the ITN (Integrated Transportation Network) (see section 3.4.2) 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. The forecasted on-road modeling inventories are developed using the same methodology as the baseline year, where future year emissions are based on running EMFAC 2014 in Emissions Mode for the associated future year.

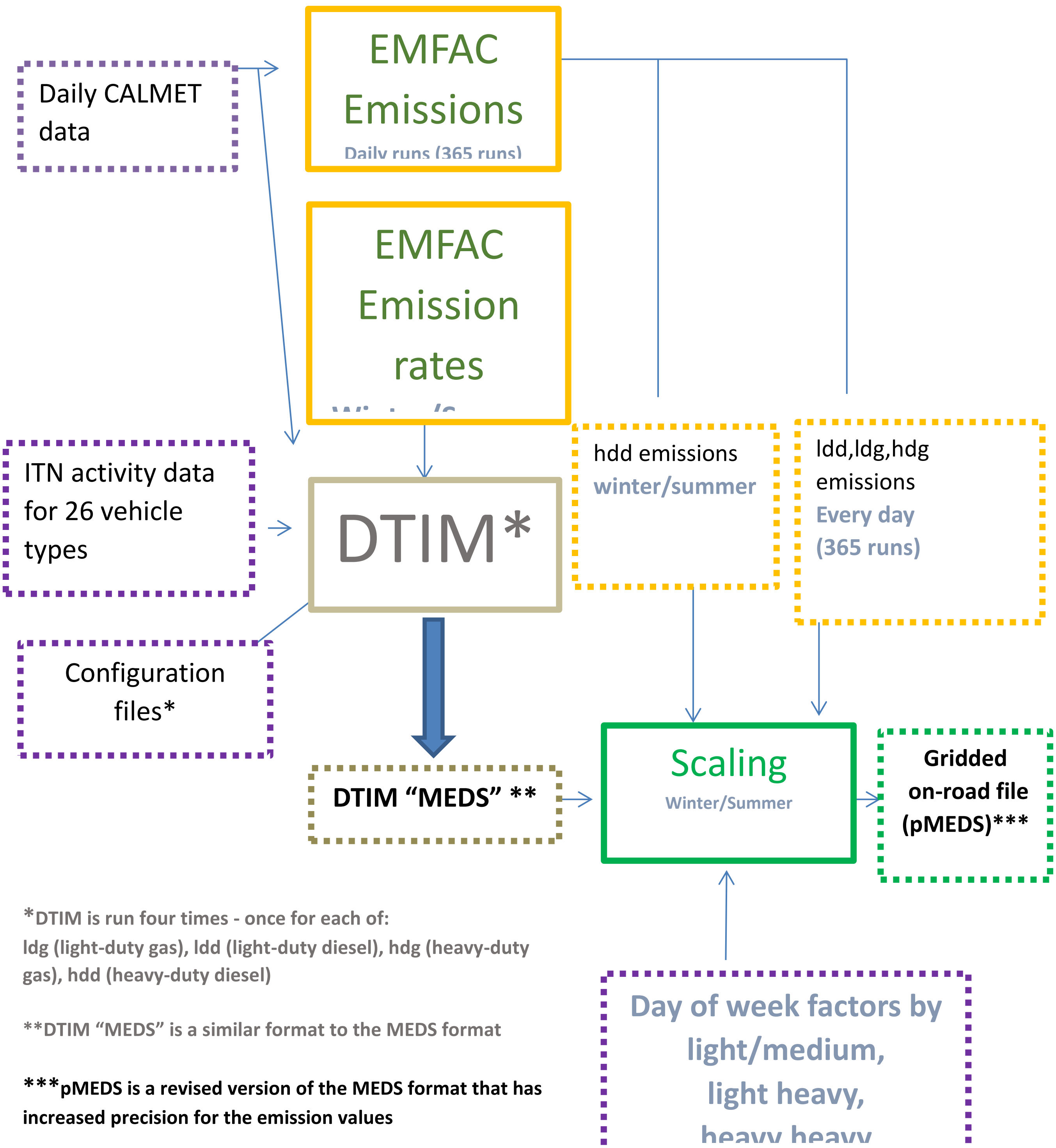


Figure 17 Block diagram for on-road processing

3.4.2. Integrated Transportation Network (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 19. 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 19 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 20. 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 20 DTIM Emission Categories

SCC for light-duty and medium-duty gasoline vehicles	SCC for heavy-duty gasoline 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 Exhaust
205	305			Non-catalyst Running Exhaust
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, 713	PM Tire Wear
214	314	814	414, 514, 614, 714	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, 720	Diesel Idle
221	321			PM Road Dust

DTIM and EMFAC2014 are both run using the 13 vehicle types shown in Table 21. 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 21 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.

Adjustment categories are light duty (LD), light medium duty trucks (LM), and heavy-heavy duty trucks (HH).

Table 21 Vehicle classification and type of adjustment

DTIM Category	EMFAC Vehicle type	Adjustment Categories
1	LDA	LD
2	LDT1	LD
3	LDT2	LD
4	MDV	LD
5	LHDT1	LM
6	LHDT2	LM
7	T6	LM
8	T7 HHDT	HH
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 to 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 in 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) wildfires and prescribed burns 2) paved and unpaved road dust 3) agricultural burns in six districts and 4) a refinery fire. Additionally, emissions in future years were removed for facilities that have closed after 2012.

For the reference and future year inventories, which are used to calculate Relative Response Factors (RRFs), day-specific emissions for wildfires, prescribed burns, wildland fires use (WFU), and the Chevron fire are left out of the inventory. All other day-specific data are included in both reference and future year modeling inventories.

3.6.1. Wildfires and Prescribed Burns

Day-specific, base case estimates of emissions from wildfires and prescribed fires were developed in a two part process. The first part consisted of estimating micro-scale, fire-specific emissions (i.e. at the fire polygon scale, which can be at a smaller spatial scale than the grid cells used in air quality modeling). The second part consisted of several steps of post-processing fire polygon emission estimates into gridded, hourly emission estimates that were formatted for use in air quality modeling.

Fire event-specific emissions were estimated using a combination of geospatial databases and a federal wildland fire emission model, first described in (Clinton, et al., 2006). A series of pre-processing steps were performed using a Geographic Information System (GIS) to develop fuel loading and fuel moisture inputs to the First Order Fire Effects (FOFEM) fire emission model (Lutes, et al., 2012). Polygons from a statewide interagency fire perimeters geodatabase (fire12_1.gdb, downloaded June 4, 2013) maintained by the Fire and Resource Assessment Program (FRAP) of the California Department of Forestry and Fire Protection (CALFIRE) provided georeferenced information on the location, size (area), spatial shape, and timing of wildfires and prescribed burns. (Under interagency Memorandums of Understanding, federal, state, and local agencies report California wildfire and prescribed burning activity data to FRAP.) Using GIS software, fire polygons were overlaid upon a vegetation fuels raster dataset called the Fuel Characteristic Classification System (FCCS) (Ottmar, et al., 2007). The FCCS maps vegetation fuels at a 30 meter spatial resolution, and is maintained and distributed by LANDFIRE.GOV, a state and federal consortium of wildland fire and natural resource management agencies. With spatial overlay of fire polygons upon the FCCS raster, fuel model codes were retrieved and component areas within each fire footprint tabulated. For each fuel code, loadings (tons/acre) for fuel categories were retrieved from a FOFEM look-up table. Fuel categories included dead woody fuel size classes, overstory live tree crown, understory trees, shrubs, herbaceous vegetation, litter and duff. Fuel moisture values for each fire were estimated by overlaying fire polygons on year- and month-specific 1 km spatial resolution fuel moisture raster files generated from the national Wildland Fire Assessment System (WFAS.net) and retrieving moisture values from fire polygon centroids. Fire event-specific fuel loads and fuel moisture values were compiled and formatted to a batch input file and run through FOFEM.

A series of post-processing steps were performed on the FOFEM batch output to include emission estimates (pounds/acre) for three supplemental pollutant species (NH_3, TNMHC and N_2O) in addition to the seven species native to FOFEM (CO, CO_2, $PM_{2.5}$, PM_{10}, CH_4, NO_x, SO_2), and to calculate total emissions (tons) by pollutant species for each fire. Emission estimates for NH_3, TNMHC and N_2O were based on mass ratios to emitted CO and CO_2 (Gong, et al., 2003).

Fire polygon emissions were apportioned to CMAQ model grid cells using area fractions, developed using GIS software, by intersecting fire polygons to the grid domain.

Another set of post-processing steps were applied to allocate fire polygon emissions by date and hour of the day. Fire polygon emissions were allocated evenly between fire start and end dates, taken from the fire perimeters geodatabase. Daily emissions were then allocated to hour of day and to the model grid cells and distributed vertically using a method developed by the Western Regional Air Partnership (WRAP), which specifies a pre-defined diurnal temporal profile, plume bottom and plume top for each fire (WRAP, 2005).

3.6.2. 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(a meteorological database maintained by the Bay Area Air Quality Management District) , and Federal Aviation Administration (FAA). FAA provides 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.

3.6.3. 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.

3.6.4. 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.

Sacramento

Sacramento Metropolitan Air Quality Management District provided information needed to calculate emissions in Sacramento 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 other solid fuels. 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 eight hours from 10:00 a.m. to 6:00 p.m.

Yolo-Solan*o*

Yolo-Solano Air Quality Management District provided information needed to calculate emissions from agricultural burning for each day of 2012 when agricultural burning occurred. Data were provided for their region: all of Yolo County and the Sacramento Valley portion of Solano County. Using the same methodology as San Joaquin Valley, emissions were estimated for the burning of prunings, field crops, weed abatement and range improvement. 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 five hours from 11:00 a.m. to 4:00 p.m.

Feather River

Feather River Air Quality Management District provided information needed to calculate emissions from agricultural and prescribed burning for each day of 2012 when agricultural burning occurred. Data were provided for Sutter and Yuba Counties. Using the same methodology as San Joaquin Valley, emissions were estimated for the burning of prunings, field crops, weed abatement, and other solid waste. The location of each 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. Orchard prunings were assumed to occur from 9:00 a.m. to 4:00 p.m. The burning of field crops, rice, weeds and ditch banks were assumed to occur from 10:00 a.m. to 5:00 p.m. from March 1 through August 31 and from 10:00 a.m. to 4:00 p.m. from September 1 through February 29. Prescribed burns over 10 acres were assumed to occur from 9:00 a.m. to 12:00 a.m. while prescribed burns less than 10 acres were assumed to occur from 9:00 a.m. to 6:00 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, range improvement and prescribed burns not included in the wildfires / prescribed burns discussed in the San Joaquin Valley portion of Section 3.6.4**Error! Reference source not found.**. Information needed to estimate emissions c ame 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.

3.6.5. Refinery Fire

On August 6, 2012, the Chevron U.S.A Inc. refinery in Richmond experienced a catastrophic pipe rupture. The flammable, high temperature gas oil flowing through the pipe ignited shortly after the release and burned for approximately 5 hours. Flaring also occurred for four days from August 6 through August 10. Bay Area Air Quality Management District (BAAQMD) staff estimated NOx and SOx emissions from both the fire and flaring; TOG emissions from flaring were also estimated. The emissions were spread evenly across the hours they occurred.

Additionally, stack data were estimated by the BAAQMD. Based on physical observation of the plume height, the first two hours of the fire were estimated to have the highest gas flow rate used in the calculation of plume rise. The gas flow rate was reduced for the latter three hours of the fire.

3.6.6. Closed Facilities

Emissions in future years were removed for facilities that have closed beyond the baseline year. In other words, the emissions were removed from future year inventories for a facility that was included in the 2012 inventory but stopped operating after 2012. Local air district staffs provided the lists of facilities.

3.7. Application of Control Measure Reduction Factors in Western Nevada county

No outside controls were added to the inventory beyond the projected 2020 emissions.

4. Quality Assurance of Modeling Inventories

As mentioned in section 1.3, base case modeling is intended to demonstrate confidence in the modeling system. Quality assurance of the data 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 18 are carefully screened for proper spatial distribution of emissions.

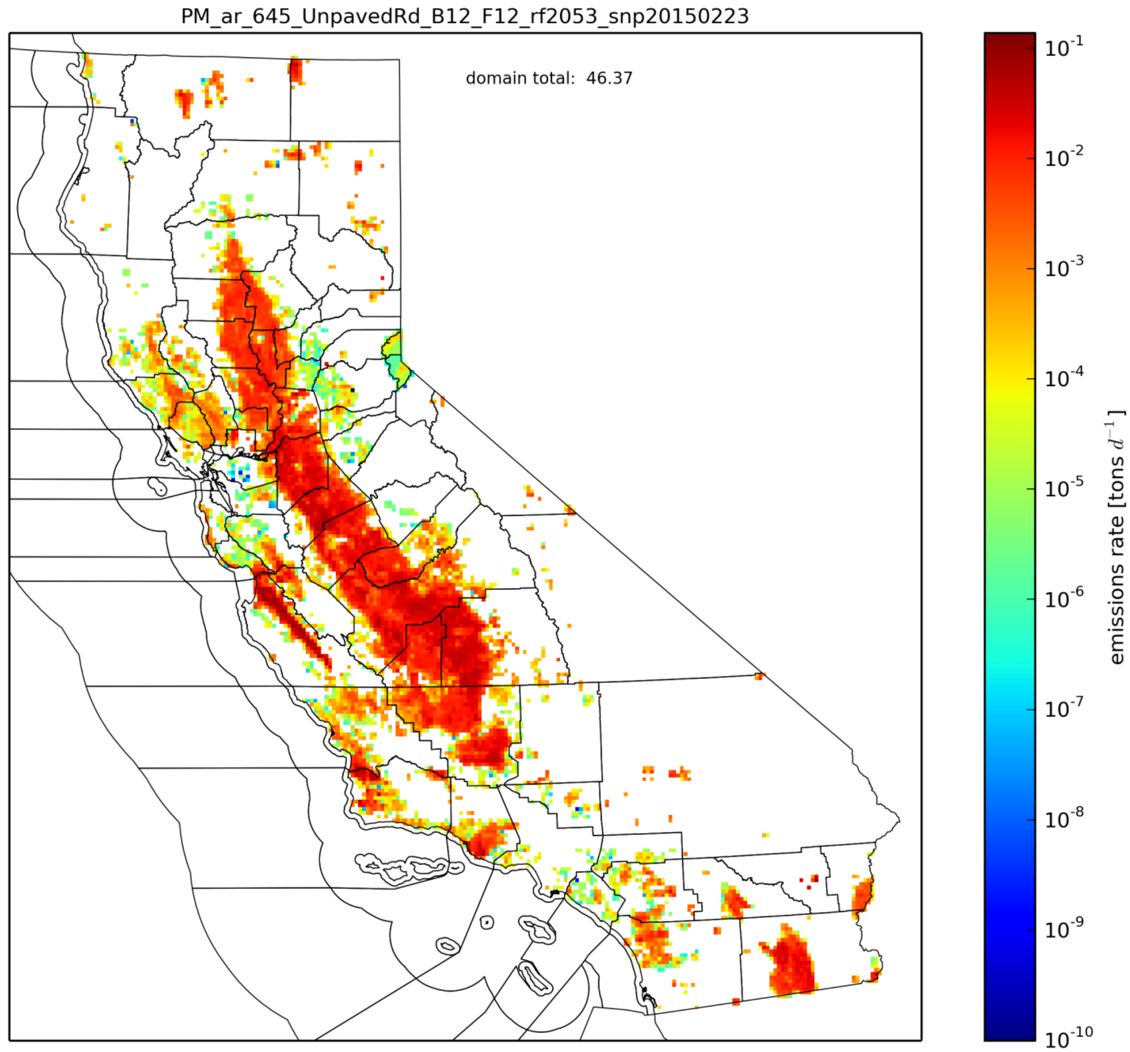


Figure 18 Example of a spatial plot by source category

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 aggregated 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 19.

```
# 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 19 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. Wildfires and Prescribed Burns: To check for potential wildfire activity data gaps in the CALFIRE interagency fire perimeters geodatabase, staff examined geospatial fire activity data reported in the national Geospatial Multi-Agency Coordination (www.geomac.gov) wildland fire geodatabase. California wildfires reported to GeoMAC were accounted for in the CALFIRE geodatabase.

Prescribed burns are performed by land and fire management agencies primarily to reduce wildfire risk to local communities associated with high loads of vegetation fuels in adjacent wildlands. Vegetation is burned during winter, in-situ or in piles following mechanical treatment. Public land management agencies also perform prescribed burning to restore the natural role of fire in selected ecosystems. To check for potential prescribed burn activity data gaps in the CALFIRE interagency fire perimeters geodatabase, staff queried data for calendar year 2012 reported to CARB's Prescribed Fire Information Reporting System (PFIRS) (). Staff discovered that CALFIRE data accounted for 38 prescribed burn projects, while PFIRS reported 453 projects. Only one burn project was accounted for in both datasets. Burn project area for CALFIRE data totaled approximately 3,780 acres, while burned acres reported to PFIRS totaled 9,097 acres. Burn projects reported to PFIRS were located in the Sierra Nevada Mountains and northern Coast Range.

Records for 651 prescribed wildland burn events reported for 2012 were downloaded from PFIRS and imported to a geodatabase. Data fields included event ("Unit") name, burned area, latitude/longitude, start and end dates. A series of geoprocessing steps were used to map and overlay prescribed burns as points on the statewide vegetation fuels (FCCS) and moisture raster datasets, to retrieve associated fuel loadings and moisture values for use as input to FOFEM. Prescribed burn points were also overlayed on the statewide 4-km modeling grid to assign grid cell IDs to each burn. Emission estimates for each prescribed burn event were generated by FOFEM and summarized in an Access database.

4.3.2. 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.

4.3.3. Unpaved Road Dust: Unpaved road dust followed the same quality assurance process as paved road dust, except that total removal rather than 25% reduction is applied whenever precipitation is greater than 0.01".

4.3.4. 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.

4.3.5. Chevron Refinery Fire: The calculations in the MEDS files were verified by hand to make sure the emissions and stack data matched what was provided by the BAAQMD.

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 20 provides a screen capture of a report that summarizes different emission categories for San Luis Obispo County. Please note that this table is only an example 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/2016oz

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 20 Screenshot of comparison of inventories report

Staff also review how modeling emissions vary over a year. Figure 21 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 only an example.

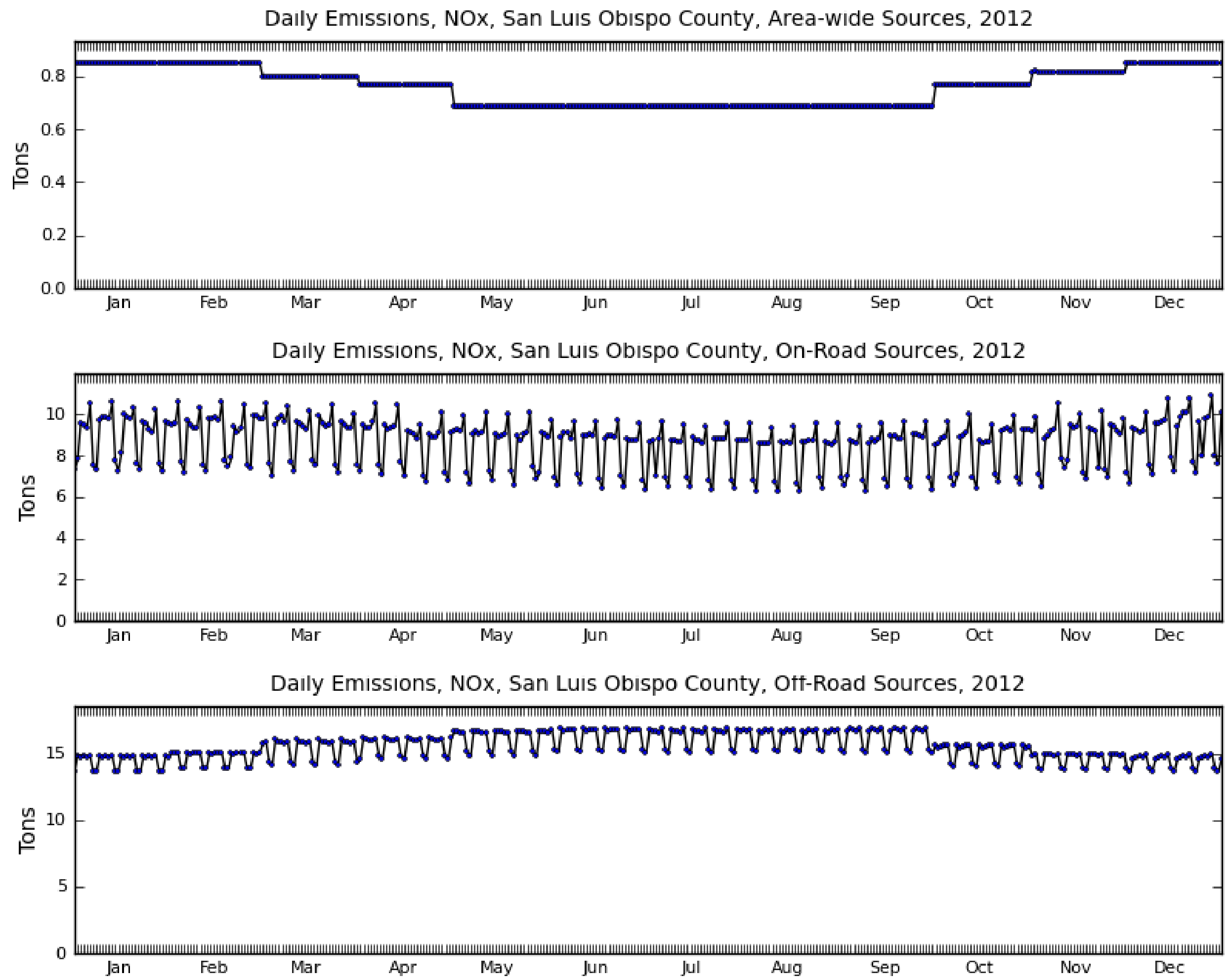


Figure 21 Daily variation of NOx emissions for mobile sources for San Luis Obispo

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.

Bibliography

Anderson, C., Carlson, T., Dulla, R. & Wilkinson, J., 2012. *AGTOOL Agricultural sector emissions allocation model – Data development. CCOS_11-2,* Sacramento, CA: Sierra Research Inc.

ARB, 2011. *Heavy Duty Diesel Vehicle Exhaust PM Speciation Profile.* [Online]
Available at:
http://www.arb.ca.gov/ei/speciate/profilereference/HDDV%20PM%20Profiles%20Final.pdf
[Accessed 2016 17 August].

ARB, 2016. *SIPIWG2.* [Online]
Available at: https://arb.ca.gov/eos/SIPIWG2/meetings/

ARB-Miscellaneous Methodologies, 2013. *District Miscellaneous Processes Methodologies - Managed Burning and Disposal.* [Online]
Available at: http://www.arb.ca.gov/ei/areasrc/distmiscprocwstburndis.htm
[Accessed 10 7 2015].

ARB-MSEI, 2015. *Mobile Source Emissions Inventory -- Categories.* [Online]
Available at: http://www.arb.ca.gov/msei/categories.htm#emfac2014
[Accessed 10 07 2015].

ARB-PTSD, 2011. *Appendix D: Emissions estimation methodology for Ocean-going vessels.* [Online]
Available at: http://www.arb.ca.gov/regact/2011/ogv11/ogv11appd.pdf
[Accessed 10 7 2015].

Baek, B. a. S. C., 2015. *Final Summary Report: Development of SMOKE version 4.0. Under contract ITS:12-764,* Sacramento, CA: s.n.

Caldwell, P. C. H. -N. B. D. a. B. G., 2009. Evaluation of a WRF dynamical downscaling simulation over California. *Climatic change,* 95(3), pp. 499-521.

Clinton, N., Gong, P. & Scott, K. 2., 2006. Quantification of pollutants emitted from very large wildland fires in Southern California. *Atmospheric Environment,* Volume 40, pp. 3686-3695.

Dun and Bradstreet, 2015. *Market insight database..* [Online]
Available at: http://www.dnb.com
[Accessed 15 June 2015].

EPA, U., 2011. *National Emissions Inventory 2011v6.* [Online]
Available at: ftp://ftp.epa.gov/EmisInventory/2011v6/v2platform/

FactFinder, U. C. B. /. A., 2011. *"B25040: House heating fue. 2013 ACS 5-year estimatesl".* [Online]
Available at: http://factfinder2.census.gov
[Accessed March 2015].

Fovell, R., 2008. *Validation of WRF Surface meteorology Simulations, presentation November 4th 2008.,* Sacramento: CCOS Technical Commitee meeting, California Air Resources Board.

Funk, t., Stiefer, P. & Chinkin, L., 2001. *Development of gridded spatial allocation factors for the state of California.,* Sacramento: STI.

Funk, t., Stiefer, P. & Chinkin, L., 2001. *Development of gridded spatial allocation factors for the state of California.,* Sacramento: STI.

Gong, P., Clinton, N. & Pu, R. T. Y. a. S. J., 2003. *Extension and input refinement to the ARB wildland fire emissions estimation model. Final report, contract number 00-729,* Sacramento, CA.: Air Resources Board.

Guenther, A. et al., 2006. Estimates of global terrestrial isoprene emissions using MEGAN (Model of Emissions of Gases and Aerosols from Nature. *Chem. Phys.,* 6(11), pp. 3181-3210.

Homer, C. et al., 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing,* 81(5), pp. 345-354.

Jackson, B., 2012. *Preparation of a gridded emissions Inventory for Mexico.* [Online] Available at: https://www.arb.ca.gov/eos/public/arb_mexico_ei.pdf
[Accessed 27 09 2016].

Karl, T. et al., 2013. Airborne flux measurements of BVOCs above Californian oak forests: experimental investigation of surface and entrainment fluxes, OH densities and Dahmkohler numbers. *J. Atmos. Sci.,* 70(10), pp. 3277-3287.

Lutes, D., Keane, R. & Reinhardt, E. 2., 2012. *FOFEM 6 User Guide. USDA Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory,* Missoula, MT 59808: s.n.

Mc. Rae, G. J., 1980. A simple procedure for calculating atmospheric water vapor concentration. *J. Air Pollution Control Association,* Volume 30, p. 384.

Misztal, P. et al., 2015. Evaluation of regional isoprene emission estimates in California based on direct airborne flux measurements. *Submitted to Atmos. Chem. Phys..*

Misztal, P. K. et al., 2014. Airborne flux measurements of biogenic volatile organic compounds over California. *Atmos. Chem. Phys.,* Volume 14, pp. 10631-10647.

Ottmar, R., Sandberg, D. & Riccardi, C. a. P. S., 2007. An overview of the Fuel Characteristic Classification System – Quantifying, classifying, and creating fuelbeds for resource planning.. *Canadian Journal of Forest Research,* 37(12), pp. 2383-2393.

Reid, S., Penfold, B. & Chinkin, L., 2006. *Emission inventory for the Central California Ozone Study (CCOS) review of spatial variations of area, non-road mobile, and point sources of emissions,* Petaluma, CA: STI.

Scott, K. & Benjamin, M., 2003. Development of a biogenic volatile organic compounds emission inventory for the SCOS97-NARSTO domain. *Atmos. Environ.,* Volume 37, Supplement 2, pp. 39-49.

Systems Applications Inc., 2001. *DTIM 4 User's Guide. Prepared for the California Department of Transportation,* Sacramento: Systems Applications, Inc..

U.S. EPA, 2011. AP 42, Compilation of Air Pollutant Emission Factors. In: *Volume 1. Chapter 13: Miscellaneous Sources. Section 13.2.1 (Paved Road).* Fifth ed. s.l.:U.S. EPA.

U.S. EPA, 2014. *Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and RegionalHaze,* North Carollina: U.S. EPA.

Valade, A., 2009. *Evaluation of the simulation of the 2006 California heat wave by WRF using satellite,* Davis, California: U.C Davis.

WRAP, 2005. *2002 Fire Emission Inventory for the WRAP Region Phase I – Essential Documentation.* [Online]
Available at:
http://www.wrapair.org/forums/fejf/documents/emissions/WRAP_2002%20EI%20Report_20050107.pdf
[Accessed 28 4 2016].

Appendix A: Day of week redistribution factors by vehicle type and county

The factors shown in Table 22 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 22 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
Glenn	Monday	0.964	0.96	0.871

County	Day of Week	LD	LM	HH
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
Mendocino	Friday	1.031	1.004	0.932

County	Day of Week	LD	LM	HH
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
San Benito	Holiday	1.083	0.755	0.607

County	Day of Week	LD	LM	HH
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
Solano	Monday	0.979	0.948	0.887

County	Day of Week	LD	LM	HH
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 23 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 23 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
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

		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	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
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

		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	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
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

		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	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
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

		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	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
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

		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	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
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
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

		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
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
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

		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
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

		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	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
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

		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	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
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

		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	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

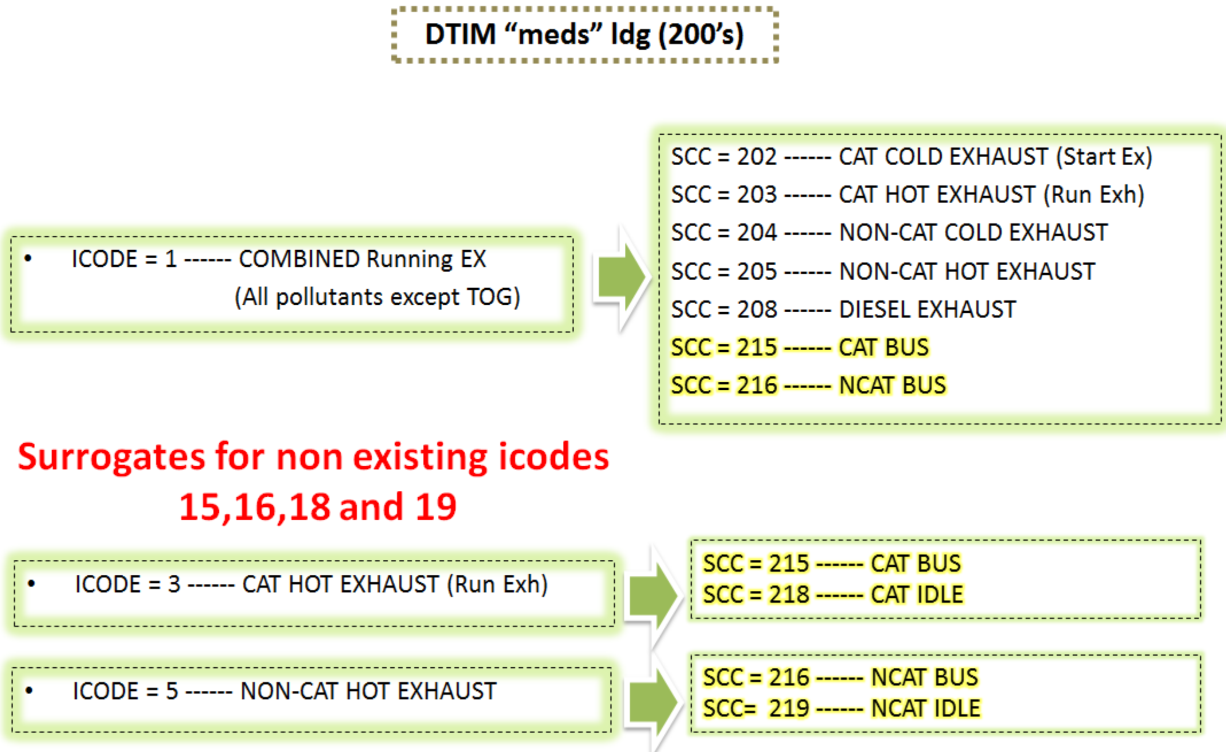
		Yolo			Yuba		
Day of Week	Hour	LD	LM	HH	LD	LM	HH
Tues/Wed/Thurs	4	0.014	0.023	0.036	0.010	0.018	0.031
Tues/Wed/Thurs	5	0.029	0.037	0.044	0.022	0.029	0.037
Tues/Wed/Thurs	6	0.046	0.051	0.052	0.042	0.047	0.044
Tues/Wed/Thurs	7	0.066	0.065	0.057	0.060	0.061	0.050
Tues/Wed/Thurs	8	0.065	0.064	0.057	0.060	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

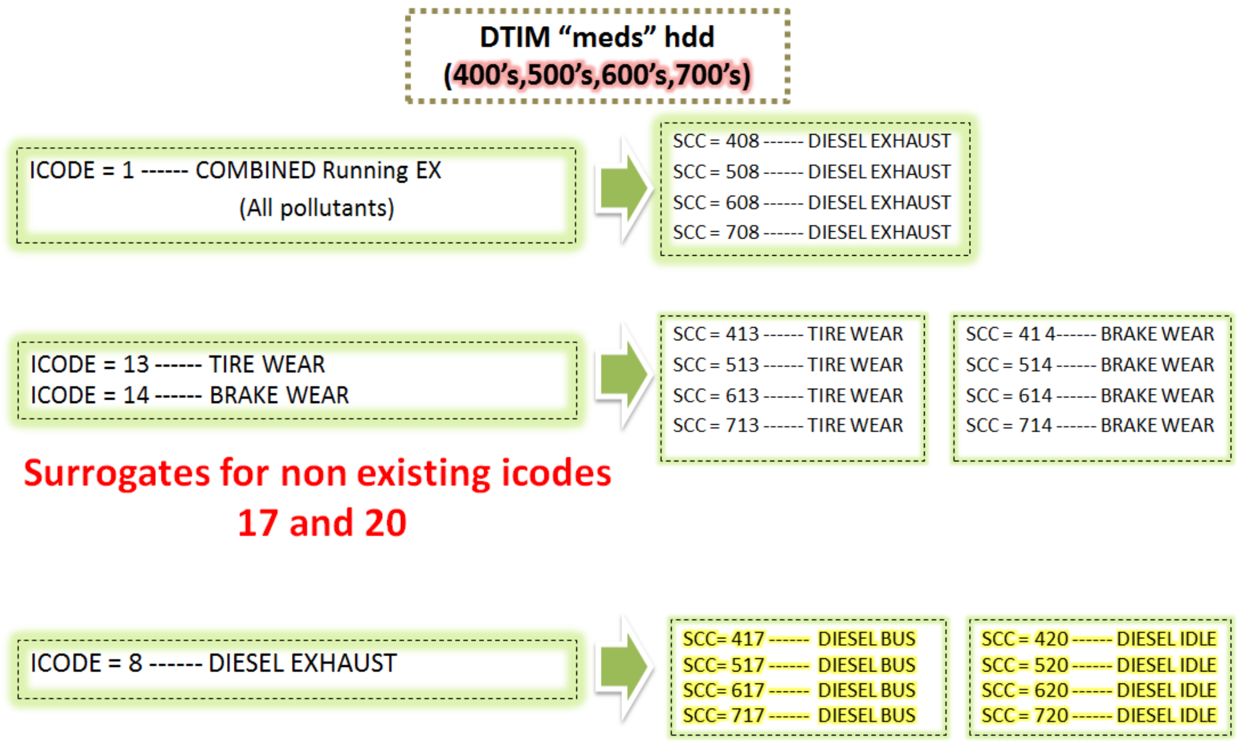
C1. Block Diagram of Scaling Process: ldg (gas: heavy- and light-duty; diesel: light-duty)

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 24 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
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

Code	M	T	W	TH	F	S	S
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 25 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

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
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
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

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
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 G

Western Nevada County Non-attainment Area (WNNA) for the 2008 NAAQS 8-hour Ozone Standard of 0.075 ppm (2018)

Table of Contents

1. TIMELINE OF THE PLAN......7

2. DESCRIPTION OF THE CONCEPTUAL MODEL FOR THE NONATTAINMENT AREA......8

2.1 History of Field Studies in the Region 8

2.2 Local Topography and Climate...... 12

2.3 Meteorological Conditions Conducive to Ozone Exceedances...... 13

2.4 Ozone Formation and Associated Chemistry...... 15

2.5 Description of the Ambient Monitoring Network...... 16

2.6 Ozone Trends and Sensitivity to Emissions Reductions...... 17

2.6.1Trend in Emissions 19

2.6.2Trend in 8-hour Ozone Design Values (DV) 20

2.6.3Ozone Weekend Effect 21

REFERENCES 23

LIST OF TABLES

Table 1-1 Timeline for Completion of the Plan (update) 7

Table 2-1. Major Field Studies in Central California and surrounding areas. 9

Table 2-2. Ozone monitoring site in the WNNA 16

LIST OF FIGURES

Figure 2-1. Map of California's central valley (left) along with the location of Western Nevada county 8-hour ozone Non-attainment Area (WNNA) in blue and Sacramento Federal 8-hour ozone Non-attainment Area (SFNA) in magenta. SV, MC and SJV denote Sacramento Valley, Mountain Counties (MC) and San Joaquin Valley (SJV) air basins. 8

Figure 2-2 Conceptual low-level wind patterns in Central California during the day (left panel) and night (right panel) for typical ozone episode conditions (adapted from Bao et al., 2008). 14

Figure 2-3. Map of the Grass Valley Ozone Monitoring Site in the Western Nevada County 8-hour ozone Non-attainment Area (WNNA) along with the location of Sacramento Federal Non-attainment Area (SFNA). 17

Figure 2-4. Illustrates a typical ozone isopleth plot, where each line represents ozone mixing ratio, in 10 ppb increments, as a function of initial NO_x and VOC (or ROG) mixing ratio (adapted from Seinfeld and Pandis, 1998, Figure 5.15). General chemical regimes for ozone formation are shown as NO_x-disbenefit (red circle), transitional (blue circle), and NO_x-limited (green circle). 18

Figure 2-5. Trends in Anthropogenic NO_x and ROG along with biogenic ROG emissions of WNNA (Western Nevada county Non-attainment Area) and SFNA (Sacramento Federal 8-hour ozone Non-attainment Area) between 2000 and 2015. 20

Figure 2-6. Trends in Western Nevada annual 4th high 8-hour ozone, 8-hour ozone design value, and biogenic ROG emissions between 2000 and 2015. 21

Figure 2-7. Average weekday and weekend maximum daily average (MDA) 8-hour ozone for each year from 2000 to 2015 for the Mojave ozone monitoring site in the WNNA. Points falling below the 1:1 dashed line represent a NO_x-disbenefit regime, those on the 1:1 dashed line represent a transitional regime, and those above the 1:1 dashed line represent a NO_x-limited regime. 22

ACRONYMS

ACHEX - Aerosol Characterization Experiment

ARCTAS-CARB – California portion of the Arctic Research of the Composition of the Troposphere from Aircraft and Satellites conducted in 2008

BEARPEX – Biosphere Effects on Aerosols and Photochemistry Experiment in 2007 and 2009

CABERNET – California Airborne BVOC Emission Research in Natural Ecosystem Transects in 2011

CalNex – Research at the Nexus of Air Quality and Climate Change conducted in 2010

CARB – California Air Resources Board

CARES – Carbonaceous Aerosols and Radiative Effects Study in 2010

CCOS - Central California Ozone Study

CIRPAS - Center for Interdisciplinary Remotely-Piloted Aircraft Studies

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

IMS-95 – Integrated Monitoring Study of 1995

IONS – Intercontinental transport experiment Ozonesonde Network Study)

LIDAR – Light Detection And Ranging

MCAB – Mountain Counties Air Basin

MDA – Maximum Daily Average

NASA – National Aeronautics and Space Administration

NOAA - National Oceanic and Atmospheric Administration

NO_x – Oxides of nitrogen

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

ROG – Reactive Organic Gases

SAOS – Sacramento Area Ozone Study

SARMAP – SJVAQS/AUSPEX Regional Modeling Adaptation Project

SFNA – Sacramento Federal Non-attainment Area

SIP – State Implementation Plan

SJV – San Joaquin Valley

SJVAB – San Joaquin Valley Air Basin (SJVAB)

SJVAQS/AUSPEX – San Joaquin Valley Air Quality Study/Atmospheric Utilities Signatures Predictions and Experiments

SVAB – Sacramento Valley Air Basin (SJVAB)

SOA – Secondary Organic Aerosol

SoCAB – Southern California Air Basin

U.S. EPA – United States Environmental Protection Agency

VOC – Volatile Organic Compounds

WNNA – Western Nevada county Non-attainment Area

WRF Model – Weather and Research Forecast Model

1. TIMELINE OF THE PLAN

Table 1-1 Timeline for Completion of the Plan (update)

Timeline	Action
Early 2018	Emission Inventory Completed
Late spring 2018	Modeling Completed
Fall 2018	District Hearing to consider the Draft Plan
Late fall 2018	ARB Board Hearing to consider Adopted Plan
Early winter 2018	Plan to be submitted to U.S. EPA

2. DESCRIPTION OF THE CONCEPTUAL MODEL FOR THE NONATTAINMENT AREA

2.1 History of Field Studies in the Region

The Western Nevada county Non-attainment Area (WNNA) for the 2008 8-hour ozone National Ambient Air Quality Standards (NAAQS) or standard is a region of highly complex terrain, with elevations ranging from a few hundred feet above sea level to over 9,000 feet. It extends from the foothills of the Sierra Nevada mountain range into the Tahoe National Forest to the east. WNNA is located in the western part of Nevada County within the Mountain Counties Air Basin (MCAB). The Northern Sierra Air Quality Management District (NSAQMD) has jurisdiction over Plumas, Sierra and Nevada County with an estimated area of ~ 978 square miles and an estimated population of 136,484 in 2010 (Fig. 2-1).

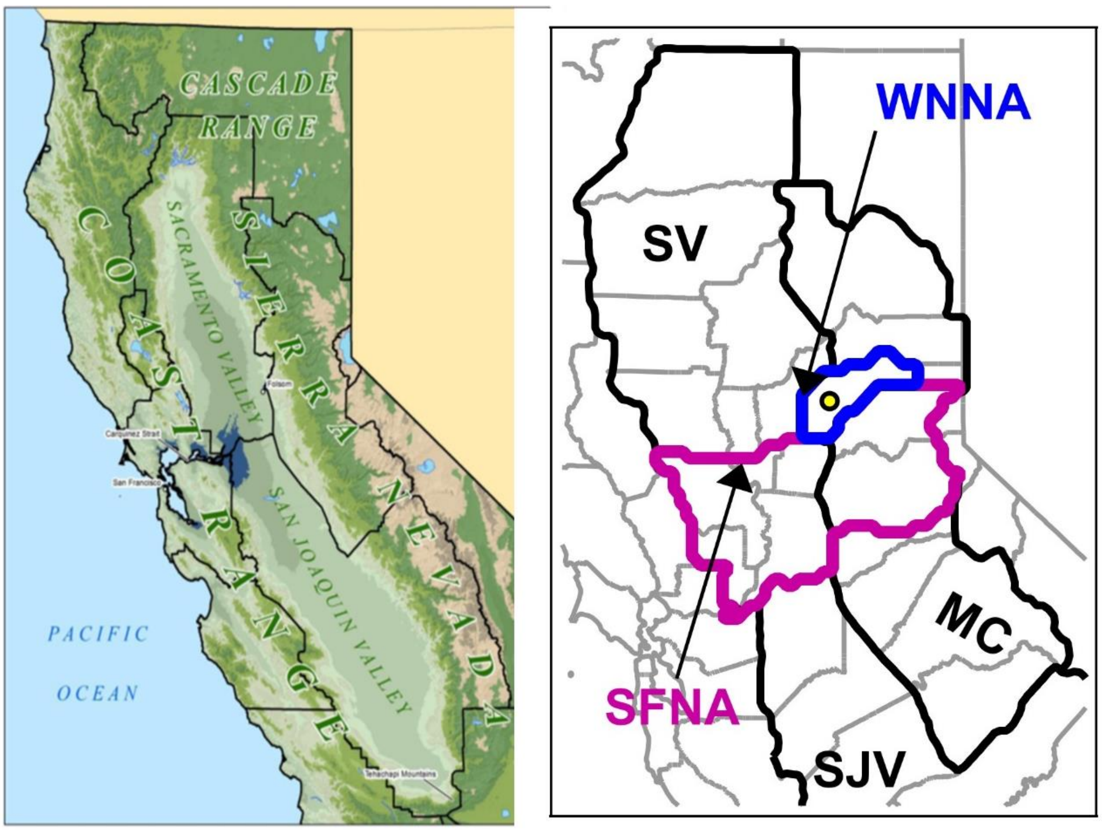


Figure 2-1. Map of California's central valley (left) along with the location of Western Nevada county 8-hour ozone Non-attainment Area (WNNA) in blue and Sacramento Federal 8-hour ozone Non-attainment Area (SFNA) in magenta. SV, MC and SJV denote Sacramento Valley, Mountain Counties (MC) and San Joaquin Valley (SJV) air basins.

The WNNA is located to the east of California's central valley in the north central portion of the Mountain Counties Air Basin (MCAB). The Central Valley is a 500 mile long northwest-southeast oriented valley encompassing two of the most polluted air basins in the nation – San Joaquin Valley Air Basin

(SJVAB) and Sacramento Valley Air Basin (SVAB). As a result, the Central Valley is one of the most studied regions in the world, in terms of the number of publications in peer-reviewed international scientific/technical journals and other major reports. The major field studies conducted within the surrounding regions including the Central Valley (listed in Table 2–1) have provided the essential knowledge base and contributed significantly to our understanding of the underlying factors (including complex terrain, meteorological conditions, chemical processes and inter-basin transport of pollutants) that typically lead to high ozone concentrations violating the 8-hour ozone standard in the WNNA.

The WNNA is located downwind of the Sacramento Federal 8–hour ozone Non-attainment Area (SFNA). An observational field study was carried out in August, 1980 to investigate the transport of ozone and its precursors from Sacramento Valley and its impact on the surrounding areas (Smith et al., 1981). The sulfur hexafluoride (SF_6) tracer results of this field study indicated that emissions from the Bay area could significantly impact the Sacramento area and downwind regions, while the emissions from Sacramento impacted the northern Sacramento Valley and downwind Sierra foothills (located to the east/northeast). The Smith et al., (1981) study also concluded that ozone and its precursors from the Bay area and Sacramento can also be transported and entrapped in the elevated layers over the valley resulting in surface level impacts on the following day.

The California Air Resources Board performed a series of transport assessments (CARB 1989; 1990; 1993; 1996; 2001) to better understand the fundamental transport relationships between different regions in California that lead to ozone exceedances. These assessments determined that from an ozone perspective, the contribution of transport from SFNA into Western Nevada was “overwhelming” (i.e. ozone exceedances were solely caused by upwind emissions) on all days.

Table 2-1. Major Field Studies in Central California and surrounding areas.

Year	**Study**	**Significance**
1970	Project Lo-Jet	Identified summertime low-level jet and Fresno eddy
1972	Aerosol Characterization Experiment (ACHEX)	First TSP chemical composition and size distributions
1979-1980	Inhalable Particulate Network	First long-term PM2.5 and PM10 mass and elemental measurements in Bay Area, Five Points
1978	Central California Aerosol and Meteorological Study	Seasonal TSP elemental composition, seasonal transport patterns

1979-1982	Westside Operators	First TSP sulfate and nitrate compositions in western Kern County
August 1980	A Study of the Origin and Fate of Air Pollutants in California's Sacramento Valley	SF-6 tracer release study to investigate the transport of ozone and precursors into, within and out of Sacramento Valley
1984	Southern SJV Ozone Study	First major characterization of O3 and meteorology in Kern County
1986-1988	California Source Characterization Study	Quantified chemical composition of source emissions
1988-1989	Valley Air Quality Study	First spatially diverse, chemical characterized, annual and 24-hour PM2.5 and PM10
July and August 1990	Sacramento Area Ozone Study	Intensive ozone measurements in the Sacramento Area
Summer 1990	San Joaquin Valley Air Quality Study/Atmospheric Utilities Signatures Predictions and Experiments (SJVAQS/AUSPEX) – Also known as SARMAP (SJVAQS/AUSPEX Regional Modeling Adaptation Project)	First central California regional study of O3 and PM2.5
July – September 1990	Upper Sacramento Valley Transport Study	Measurements to study the transport of pollutants from the lower to upper Sacramento Valley
July and August 1991	California Ozone Deposition Experiment	Measurements of dry deposition velocities of O3 using the eddy correlation technique made over a cotton field and senescent grass near Fresno
Winter 1995	Integrated Monitoring Study (IMS-95, the CRPAQS Pilot Study)	First sub-regional winter study

December 1999–February 2001	California Regional PM10/PM2.5 Air Quality Study (CRPAQS) and Central California Ozone Study	First year-long, regional-scale effort to measure both O_3 and $PM_{2.5}$
December 1999 to present	Fresno Supersite	First multi-year experiment with advanced monitoring technology
July 2003	NASA high-resolution lidar flights	First high-resolution airborne lidar application in SJV in the summer
February 2007	U.S. EPA Advanced Monitoring Initiative	First high-resolution airborne lidar application in SJV in the winter
August-October 2007; June-July 2009	BEARPEX (Biosphere Effects on Aerosols and Photochemistry Experiment)	Research-grade measurements to study the interaction of the Sacramento urban plume with downwind biogenic emissions
June 2008	ARCTAS - CARB	First measurement of high-time resolution (1-10s) measurements of organics and free radicals in SJV
May-July 2010	CalNex 2010 (Research at the Nexus of Air Quality and Climate Change)	Expansion of ARCTAS-CARB type research-grade measurements to multi-platform and expanded geographical area including the ocean.
June 2010	CARES (Carbonaceous Aerosols and Radiative Effects Study)	Research-grade measurements of trace gases and aerosols within the Sacramento urban plume to investigate SOA formation
May – June 2010	IONS (Intercontinental transport experiment Ozonesonde Network Study)	Daily Ozonesonde measurements from four coastal and two inland sites in California to improve the characterization of western U.S. baseline ozone
June 2011	CABERNET (California Airborne BVOC Emission Research in Natural Ecosystem Transects)	Provided the first ever airborne flux measurements of isoprene in California
January-February 2013	DISCOVER-AQ (Deriving Information of Surface Conditions from Column and Vertically Resolved	Research-grade measurements of trace gases and aerosols during two $PM_{2.5}$ pollution episodes in the SJV

	Observations Relevant to Air Quality)	

The impact of transported pollutants on ozone air quality in a downwind region like the WNNA is governed by various factors, including complex terrain and topographic features, precursor emissions in the upwind source regions (SFNA and Bay Area), local emissions from anthropogenic and naturally occurring biogenic ROG sources, as well as the prevailing meteorological conditions that facilitate transport of ozone and its precursors. In addition, the formation of ozone and the associated chemistry along the transport pathways, as well as the prevailing ozone chemistry regimes both locally and in the upwind source regions, play an important role in determining ozone levels in the region. These factors are discussed in the following sections.

2.2 Local Topography and Climate

Nevada County is located in the foothills and mountains of the Sierra Nevada mountain range with elevations increasing from roughly 300 feet above mean sea level (MSL) in the west to over 9,000 feet in the east, at the Sierra crest (CAPCOA, 2015). It encompasses an area of 978 square miles and is home to ~100,000 residents. Nevada County is characterized by river valleys running roughly east-northeast to west-southwest, separated by mountain ridges. This tends to inhibit north-south air flow, but allows east-west upslope and downslope flow. The western portions of the county slope relatively gradually with deep river canyons running from southwest to northeast toward the crest of the Sierra Nevada range. East of the divide, the slope of the Sierra is steeper, but river canyons are relatively shallow. The warmest areas in Nevada County are found at the lower elevations along the county's west side, while the coldest average temperatures are found at the highest elevations.

The region has a Mediterranean climate type, with seasonal variation in temperature and precipitation. Summers are hot and dry, while winters are cool and wet occurring from late October to early May. The prevailing wind direction over the county is westerly. However, the terrain of the area has a great influence on local winds, so that a wide variability in wind direction can be expected. Afternoon winds are generally channeled up-canyon, while nighttime winds generally flow down-canyon. Winds are, in general, stronger in spring and summer and weaker in fall and winter. Periods of calm winds and clear skies in fall and winter often result in strong, ground based inversions forming in mountain valleys. These layers of very stable air restrict the dispersal of pollutants, trapping these pollutants near the ground, representing the worst conditions for local air pollution occurring in the county (https://www.mynevadacounty.com/DocumentCenter/View/11228/50-Air-Quality-PDF?bidId=).

Regional airflow patterns have an effect on air quality patterns by directing pollutants downwind of sources. Localized meteorological conditions, such as light winds and shallow vertical mixing, and topographical features, such as the surrounding mountain ranges, can create areas of high pollutant concentrations by hindering dispersal. The local sources of pollution along with polluted air masses from the nearby regions (SFNA and Bay Area) that are frequently transported into this area tend to stagnate over Western Nevada under unfavorable meteorological conditions, resulting in high ozone levels which exceed the 8-hour ozone NAAQS.

2.3 Meteorological Conditions Conducive to Ozone Exceedances

California's proximity to the ocean, its complex terrain, and diverse climate produces unique synoptic and mesoscale meteorological features that lead to pollution episodes. In the summertime, the majority of the storm tracks are far to the north of the state and a semi-permanent Pacific high typically sits off the California coast. Interactions between this eastern Pacific subtropical high pressure system and the thermal low pressure further inland over the Central Valley lead to conditions conducive to pollution buildup over large portions of the state (Fosberg and Schroeder, 1966; Bao et al., 2008).

The WNNA is located in the highly complex terrain region to the east of California's Central Valley (See Figure 2-1). Elevations in the Central Valley extend from a few feet to almost 500 feet above sea level. This long valley is surrounded by the Coastal Mountain Range on the west, the Cascade Range to the northeast, the Sierra Nevada Mountains on the east, and the Tehachapi Mountains to the south. The Coastal Range is actually a series of north/south mountain ranges that extend 800 miles from the northwest corner of Del Norte County south to the Mexican border. The San Francisco Bay Area divides the Coastal Mountain Range into northern and southern ranges. The Coastal Mountains generally form a barrier between the Pacific Ocean and the Central Valley, with occasional breaks created by low elevation passes and the small gap between the northern and southern ranges in the San Francisco Bay area known as the Carquinez Strait. Elevations in the Coastal Range generally vary between 2,000 and 4,000 feet, but can reach heights above 7,000 feet. In contrast, elevations in the Cascade Range and Sierra Mountains in northern California are typically above 5,000 feet and can exceed 10,000 feet.

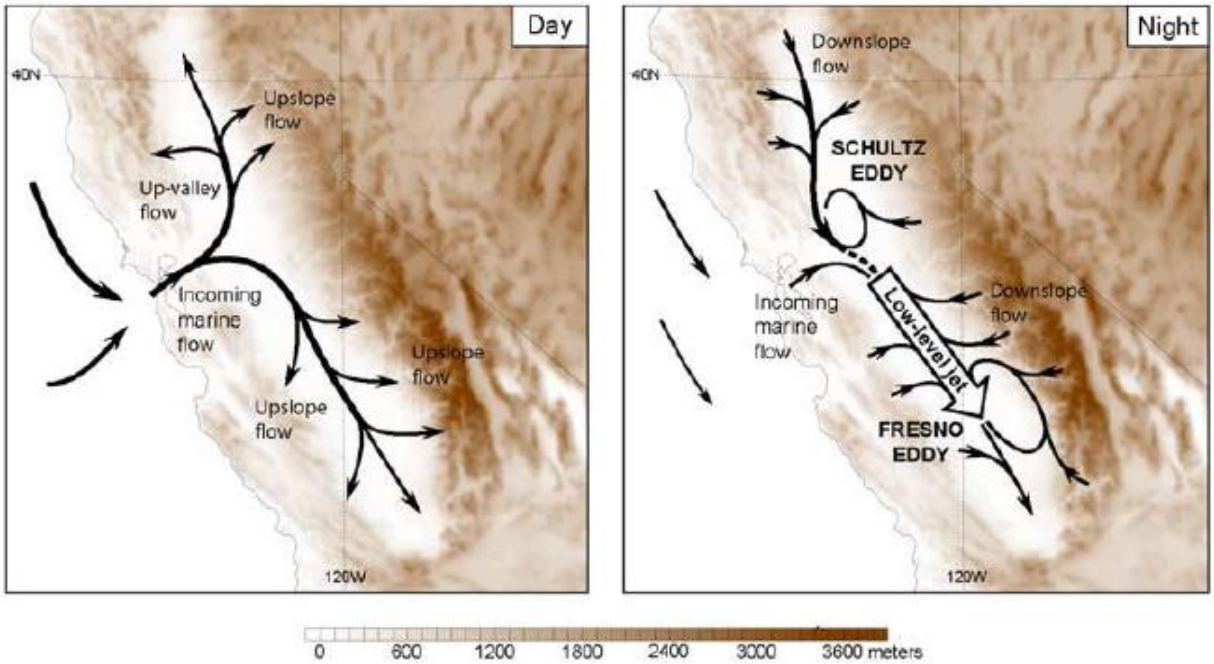


Figure 2-2 Conceptual low-level wind patterns in Central California during the day (left panel) and night (right panel) for typical ozone episode conditions (adapted from Bao et al., 2008).

Weather conditions during much of the summer ozone season are dominated by an area of high pressure, known as the East Pacific Ridge, which creates a broad region of warm, descending air over Central California. Studies have shown that the strength and positioning of this ridge has a strong influence on the prevailing weather conditions and summertime ozone levels in Central California (Lehrman et al., 2004; Pun et al., 2008). Synoptic forcing under the East Pacific Ridge is typically weak, with wind flows above the planetary boundary layer from the northwest, resulting in wind flows in Central California that are primarily thermally driven and strongly influenced by orographic effects (Zhong et al., 2004). Thermal gradients between the eastern Pacific Ocean and inland in the Valley result in a strong daytime sea breeze which follows the terrain and can extend well inland through the Carquinez Strait and to a lesser extent the Altamont, Pacheco, and Cholame Passes. When meteorological conditions are favorable, polluted air masses from the Bay Area travel through the Carquinez Strait and bifurcate over the Delta region, with one branch flowing to the northeast into the southern Sacramento Valley and the other branch flowing southeast into the northern San Joaquin Valley (Figure 2-2).

At night, the sea breeze gradually weakens and can even reverse in some cases, but up-valley flow off of the Delta usually persists. Nighttime surface wind flow in the Central Valley is dominated by downslope flows, known as nocturnal drainage, off of the mountain ranges on all sides (Figure 2-2) and when combined with the continued up-valley flows from the Delta, result in low-level eddies such as the Schultz eddy in the southern Sacramento Valley and the Fresno eddy in the SJV (Lehrman et al., 2004). The dynamical conditions favorable for the formation of both the Fresno and Shultz eddies are investigated and discussed by Lin and Jao (1995).

Clustering and classification techniques have been utilized on both observed meteorology (Lehrman et al., 2001; Blanchard et al., 2008; Beaver and Palazoglu, 2009) and observed and modeled ozone (Fujita et al., 1999; Jin et al., 2011) in the Valley and the surrounding region to better understand the relationship between meteorology and elevated ozone. These various studies reveal that the position and strength of the Pacific High has a dominant influence on ozone levels throughout the Central Valley, along with the height of the marine inversion and strength of the low-level on-shore flow. Synoptic flows that weaken or break down the Pacific High result in lower ozone throughout the Central Valley, while a strong sea breeze with a deep marine boundary layer results in lower ozone levels within the Bay Area, but also an enhanced transport of polluted air masses into the Delta region. Under such conditions, elevated ozone can occur in the Sacramento and its downwind regions if the synoptic forcing is sufficiently weak so that vertical mixing is reduced and recirculation is enhanced. The highest ozone levels occur as the thermal gradient between off-shore and inland weakens and the high pressure system strengthens. The ozone levels remain elevated until a synoptic system moves through the area and breaks down the Pacific High.

The WNNA borders the SFNA in the southwest. The SFNA is located in the northern portion of the California's Central Valley and is home to more than 2 million residents encompassing an area of 5600 square miles and occupies the southern portion of the Sacramento Valley It extends southward to the Sacramento Delta Region and northward to include the southern portion of Sutter County. The northern branch of the flow through the Carquinez Strait and the recirculation pattern in the southern Sacramento Valley as depicted in Figure 2-2 lead to the transport of elevated ozone and its precursors from the SFNA and the Bay Area into the WNNA. As these air masses move downwind, ozone is continuously formed along the way through photochemical reactions resulting even high ambient ozone concentrations. The Nevada County air flow is most frequently from the south-southwest, which coincides with the transport path (U.S. EPA, 2012). This transport pattern was also observed and documented in the past field studies (Smith et al., 1981). Ozone and its precursors from the Bay Area and the SFNA can also be directly transported and carried aloft, which could also impact the surface ozone values in the WNNA.

2.4 Ozone Formation and Associated Chemistry

The ozone levels in the WNNA are not only influenced by ozone transported out of the SFNA and the Bay Area, but also by ozone that is formed along the transport pathways that bring polluted air masses from the upwind source regions into Western Nevada. As the air masses laden with ozone and its precursors including NO_x and ROG move downwind, ozone is continuously formed through photochemical reactions in the presence of sunlight along the way, which leads to enhanced ozone levels by the time the air masses reach the WNNA.

The role of biogenic ROG precursors also becomes increasingly important during this downwind transport process. The WNNA, a region of highly complex terrain (with elevations ranging from a few hundred feet above sea level to over 9,000 feet), has diverse vegetation coverage. It lies in close proximity and directly downwind of SFNA, and has large amounts of reactive biogenic ROG precursors, which can react with the transported NO_x from the upwind source region to produce enhanced ozone levels along the transport pathway.

As the air masses are transported downwind, NO_x is removed more rapidly than ROG and the lack of fresh NO_x emissions along the transport path can prevent the scavenging of ozone by NO, which causes ozone levels to remain high during the transport process. The nighttime ozone levels also have a significant impact on ozone air quality in areas impacted by transported pollutants such as the WNNA. Typically, the nighttime ozone levels are lower in areas with the continuous influx of fresh NO_x emissions (e.g. Metropolitan areas), due to removal of ozone through reaction with NO in the absence of photolysis (i.e., no sunlight). However, in regions like the WNNA the absence of large sources of fresh NO_x emissions at night prevents the removal of ozone through the NO_x titration process, and allows the nighttime ozone levels to remain elevated. This can facilitate pollutant carryover the following morning, and can contribute to elevated ozone levels on the following day.

2.5 Description of the Ambient Monitoring Network

As discussed above, the WNNA, is largely mountainous and is located downwind of the heavily polluted SFNA and Bay Area, which pose many issues to the region's ozone air quality. The transport of pollutants from the SFNA are generally thought to significantly contribute to the exceedances of the ozone NAAQS in the WNNA.

The region's air quality planning is led by the Northern Sierra Air Quality Management District (NSAQMD). The NSAQMD also operates the Grass Valley monitoring station, located at 200 Litton Dr., Suite 230 (Figure 2-3). The Grass Valley monitor is at an elevation of 865 m, and has been in operation since June 1993 (see Table 2-2 for longitude/latitude information). The monitor was located to capture the highest ozone mixing ratios and assess regional transport patterns in the WNNA. The air quality monitoring data aids in determining compliance with the NAAQS and for improving regional air quality and protecting public health. A detailed discussion about the monitoring network and its adequacy can be found in the 2018 Air Monitoring Network and Assessment Plan (https://www.arb.ca.gov/aqd/amnr/amnr.htm).

Table 2-2. Ozone monitoring site in the WNNA

Site ID (AQS/ARB)	Site (County, Air Basin)	Ozone	$PM_{2.5}$	Latitude	Longitude	Elevation (m)
060570005 (29800)	Grass Valley-Litton Building (Nevada, MCAB[71])	X	X	39.23352	-121.05567	865

[71] MCAB denotes the Mountain Counties Air Basin.

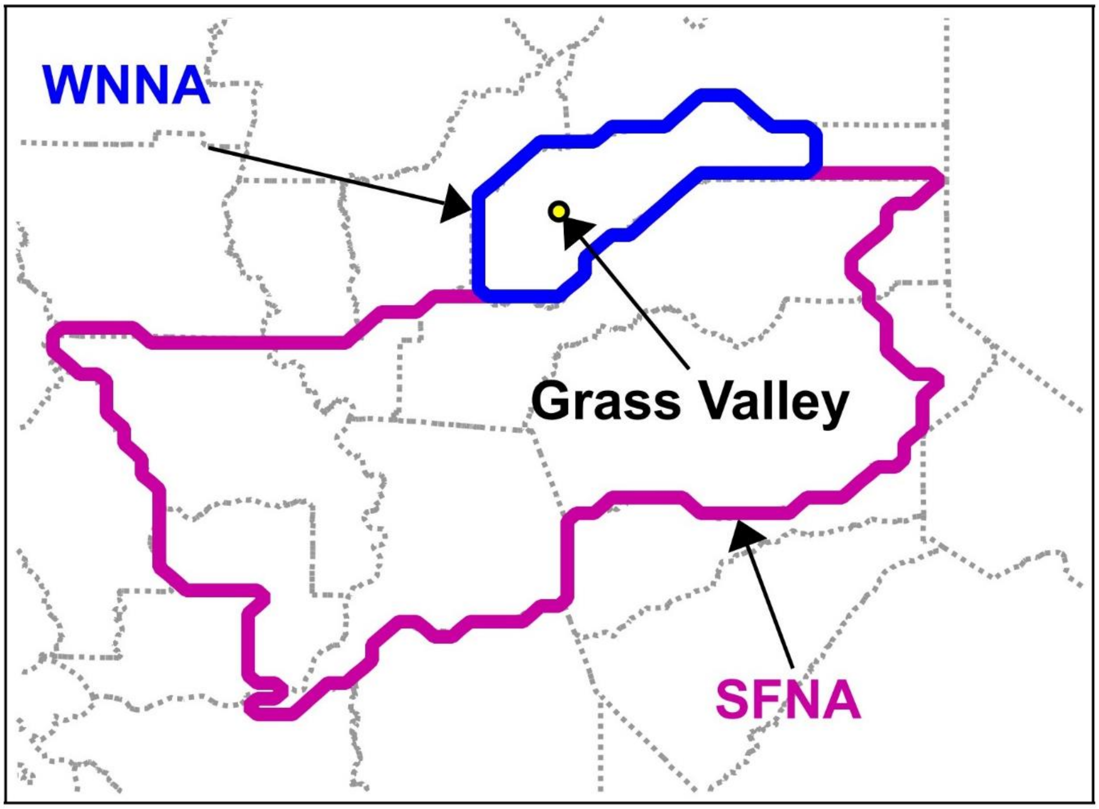


Figure 2-3. Map of the Grass Valley Ozone Monitoring Site in the Western Nevada County 8-hour ozone Non-attainment Area (WNNA) along with the location of Sacramento Federal Non-attainment Area (SFNA).

2.6 Ozone Trends and Sensitivity to Emissions Reductions

The Western Nevada county 8–hour ozone Non-attainment Area (WNNA) is designated as a moderate ozone nonattainment area for the U.S. EPA 2008 0.075 ppm 8-hour ozone standard. The major precursors that lead to ozone formation in this region are the emissions of anthropogenic NO_x and ROG (both local and transported), as well as natural biogenic ROG emissions. There is a relatively lower contribution from local emissions, which are dominated by stationary and mobile sources. Since the 1980's, California's emission control programs have substantially reduced the amounts of both anthropogenic NO_x and ROG throughout the region (https://www.arb.ca.gov/aqd/almanac/almanac.htm). As these control programs have led to changes in the relative levels of NO_x and ROG over time, the control programs have also adapted so as to reduce ozone levels as rapidly as possible. This adaptation within the control programs is necessary because ozone formation responds differently to NO_x and ROG controls as the relative levels of NO_x and ROG in the atmosphere change.

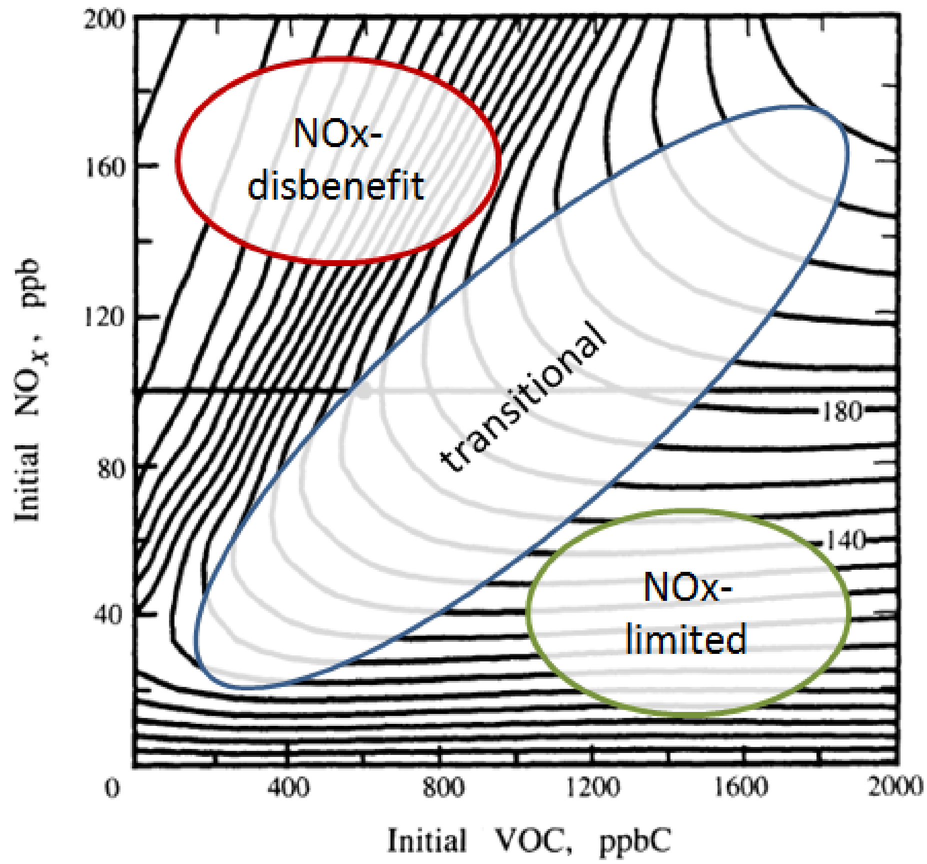


Figure 2-4. Illustrates a typical ozone isopleth plot, where each line represents ozone mixing ratio, in 10 ppb increments, as a function of initial NO_x and VOC (or ROG) mixing ratio (adapted from Seinfeld and Pandis, 1998, Figure 5.15). General chemical regimes for ozone formation are shown as NO_x-disbenefit (red circle), transitional (blue circle), and NO_x-limited (green circle).

Specifically, ozone formation exhibits a nonlinear dependence to NO_x and ROG precursors in the atmosphere. In general terms, under ambient conditions of high-NO_x and low-ROG (NO_x-disbenefit region in Figure 2-4), ozone formation tends to exhibit a disbenefit to reductions in NO_x emissions (i.e., ozone increases with decreases in NO_x) and a benefit to reductions in ROG emissions (i.e., ozone decreases with decreases in ROG). In contrast, under ambient conditions of low-NO_x and high-ROG (NO_x-limited region in Figure 2-4), ozone formation shows a benefit to reductions in NOx emissions, while changes in ROG emissions result in only minor decreases in ozone. These two distinct "ozone chemical regimes" are illustrated in Figure 2-4 along with a transitional regime that can exhibit characteristics of both the NO_x-disbenefit and NO_x-limited regimes. Note that Figure 2-4 is shown for illustrative purposes only, and does not represent the actual ozone sensitivity within the WNNA for a given combination of NO_x and VOC (ROG) emissions.

The prevailing chemical regime for ozone formation and the associated trend can be analyzed through the year-to-year variability in biogenic ROG emissions, which during the summer ozone season can be many times greater than anthropogenic ROG emissions in the WNNA, as well as through the so called "weekend effect" which shows an increase in ozone on the weekend under NO_x -disbenefit conditions (and a decrease under NO_x-limited conditions).

2.6.1 Trend in Emissions

Area-wide summer emission trends from 2000 to 2015 in the WNNA are shown in Figure 2-5 for anthropogenic NO_x and ROG, as well as biogenic ROG. Figure 2-5 clearly shows a significant decrease in both local anthropogenic NO_x (from 9.6 tpd to 5.2 tpd) and ROG (from 8.2 tpd to 5.2 tpd) emissions from 2000 to 2012. The anthropogenic NO_x and ROG emissions continued to decline from 2012 to 2015.

The transport of pollutants from the SFNA can significantly contribute to the exceedances of the federal ozone NAAQS in the WNNA. As such, it is useful to look at the emissions trend in SFNA since emissions from this regions are readily transported into the WNNA. The anthropogenic NO_x and ROG emissions trends for SFNA is also displayed in Figure 2-5 and shows large decreases in both anthropogenic NO_x (from 184 tpd to 103.6 tpd) and ROG (from 173 tpd to 110 tpd) emissions from 2000 to 2012. However, the SFNA emissions are much higher when compared to local sources, and specifically for 2012, the SFNA anthropogenic NO_x and ROG emissions are ~20 times higher than the corresponding local emissions in WNNA for 2012. It can be clearly seen from Figure 2-5 that the upwind source region has emissions that are an order of magnitude or higher than the local emissions, and when aided by conducive meteorological conditions (that facilitate pollutant transport), can be the dominant contributor to ozone levels in this region.

Over the same time period, the biogenic ROG emissions in WNNA exhibited large year-to-year variability, ranging from ~179 tpd in 2005 to ~303 tpd in 2006. However, even at its lowest levels, biogenic ROG is estimated to be ~25 times as high as the anthropogenic ROG inventory in 2005 and upwards of 45 times as high during peak biogenic years. The biogenic emissions for the upwind SNFA vary year-by-year but are estimated to be ~5 times higher than the corresponding anthropogenic emissions.

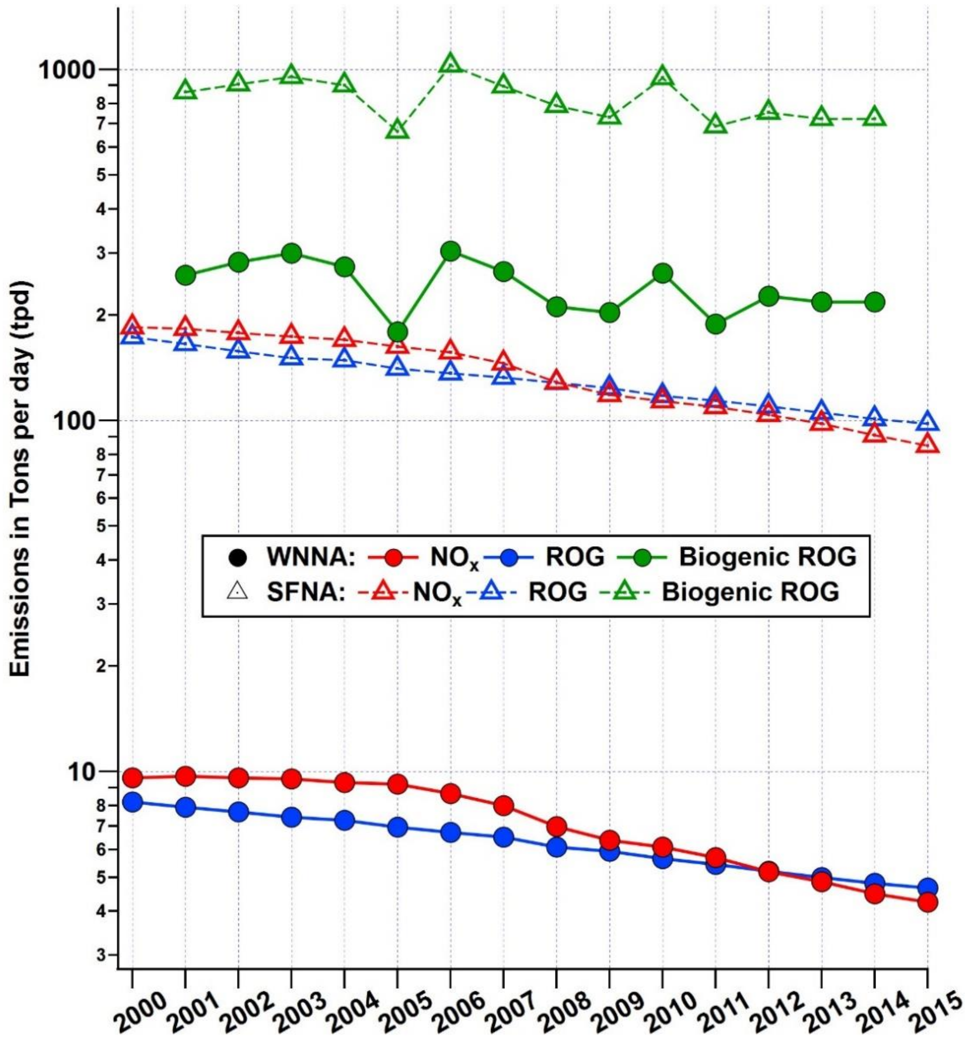


Figure 2-5. Trends in Anthropogenic NO_x and ROG along with biogenic ROG emissions of WNNA (Western Nevada county Non-attainment Area) and SFNA (Sacramento Federal 8-hour ozone Non-attainment Area) between 2000 and 2015.

2.6.2 Trend in 8-hour Ozone Design Values (DV)

Over the same 2000 to 2015 time period, the 8-hour ozone design values (DVs) and 4th highest values (used to calculate the DVs) within the WNNA declined steadily (Figure 2-6), but also exhibited a fair amount of variability due to year-to-year differences in meteorology, which impacts the transport of pollutants from upwind sources and the associated changes in biogenic emissions. Overall, the area-wide design values have declined by ~15 ppb from 96 ppb in 2000 to 81 ppb in 2015, albeit with fluctuations due to the year-to-year meteorological variability. However, these DVs are still substantially higher than the 2008 8-hour ozone standard of 75 ppb.

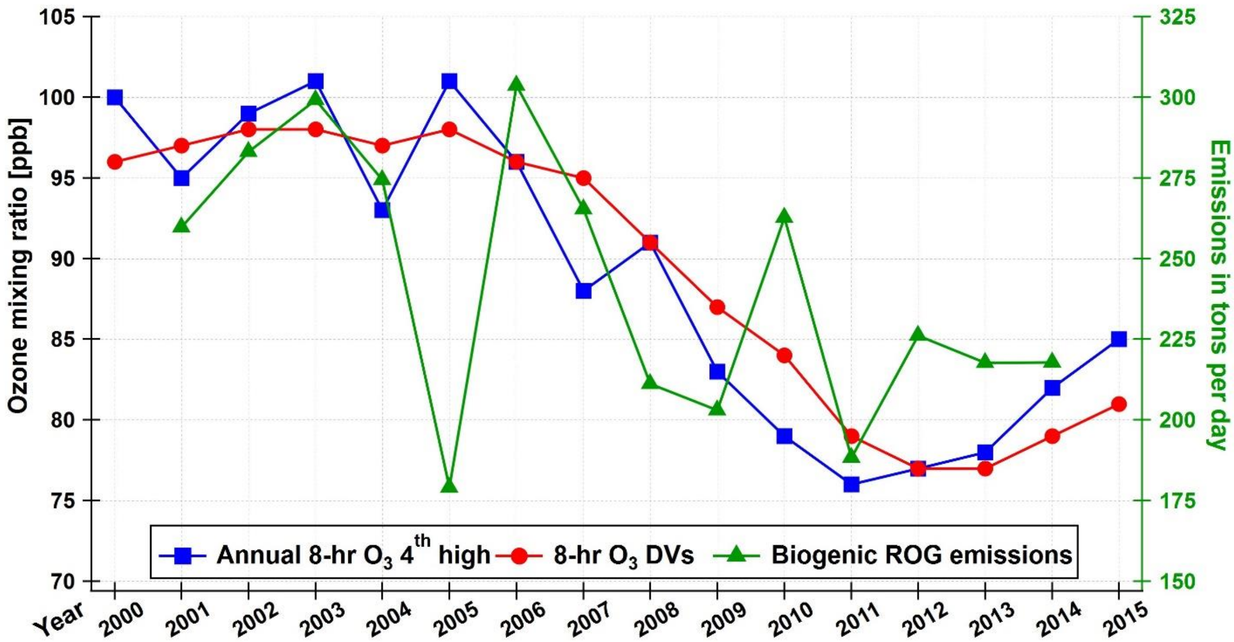


Figure 2-6. Trends in Western Nevada annual 4th high 8-hour ozone, 8-hour ozone design value, and biogenic ROG emissions between 2000 and 2015.

Comparing the year-to-year variability in ozone DVs and annual 4th highest values to similar variability in the biogenic ROG emissions, can sometimes provide evidence regarding the ozone chemistry regime for a region. For example, in areas that exhibit a strong NO_x-disbenefit, year-to-year variability in peak ozone will often be correlated to changes in biogenic ROG emissions (i.e., when biogenic ROG emissions increase, peak ozone will also increase). In WNNA, this correlation between biogenic ROG emissions and peak ozone was present from 2000 to 2004 (Figure 2-6), but after 2004 the two were generally anticorrelated, suggesting that the region is likely NO_x-limited and that other factors beyond chemistry, such as meteorology and wildfires, play a large role in the year-to-year variability in ozone.

2.6.3 Ozone Weekend Effect

Investigating the "weekend effect" and how it has changed over time is also a useful metric for evaluating the ozone chemistry regime in the WNNA. The weekend effect is a well-known phenomenon in some major urbanized areas where emissions of ozone precursors (in particular NO_x) are substantially lower on weekends than on weekdays, but the corresponding ozone levels are higher on weekends than on weekdays. Under these conditions, the region is considered to be in a NO_x-disbenefit (or VOC-limited) chemistry regime for ozone, where ozone increases with decreasing NO_x emissions. The excess NO_x in this regime not only titrates the O_3 but also mutes the VOC reactivity by using Peroxy radicals to terminate NO_2 as NO_3 radicals and subsequently HNO_3. The reduction of NO_x during the weekend (mainly due to the reduced motor vehicle and diesel truck activity) would lessen the titration and increase the VOC reactivity. The final result is elevated O_3 mixing ratios occurring disproportionally on weekends. When the opposite is true (i.e., higher ozone on weekdays than on weekends), the region is considered to be in a NO_x-limited chemistry regime (Heuss et al., 2003). A lack of a weekend effect (i.e., no pronounced high O_3 occurrences during weekends) would suggest that the region is transitioning from a NO_x-disbenefit to a NO_x-limited regime.

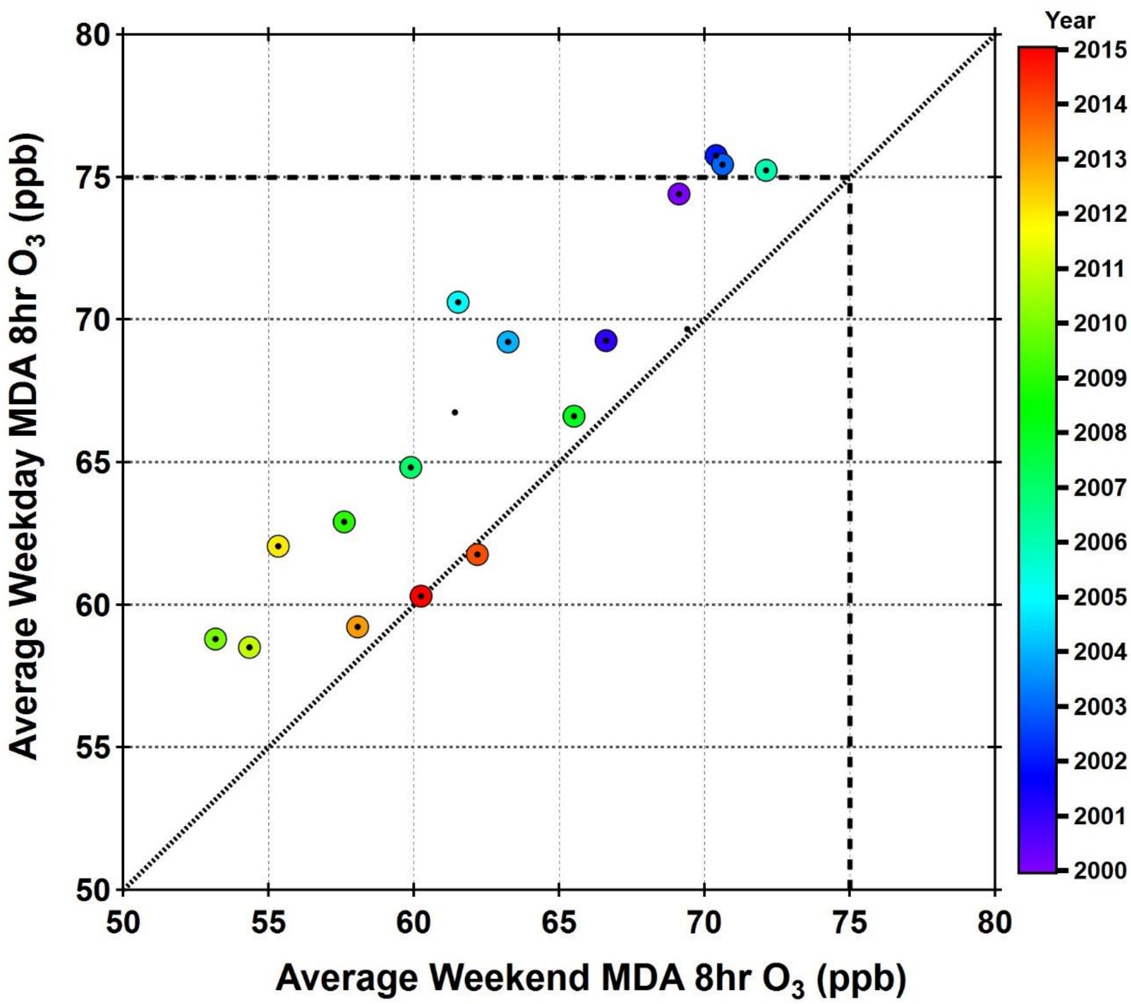


Figure 2-7. Average weekday and weekend maximum daily average (MDA) 8-hour ozone for each year from 2000 to 2015 for the Mojave ozone monitoring site in the WNNA. Points falling below the 1:1 dashed line represent a NO_x-disbenefit regime, those on the 1:1 dashed line represent a transitional regime, and those above the 1:1 dashed line represent a NO_x-limited regime.

The trend in day-of-week dependence in the WNNA was analyzed using the ozone observations between 2000 and 2015 and the average site-specific weekday (Wednesday and Thursday) and weekend (Sunday) summertime (June through September) maximum daily average (MDA) 8-hr ozone value (Figure 2-7). Different definitions of weekday and weekend days were also investigated and did not show appreciable differences from the Wednesday/Thursday and Sunday definitions. A key observation in Figure 2-7 is that the summertime average weekday and weekend ozone levels have steadily declined between 2000 and 2015, which is consistent with the decline in the area-wide DVs and 4th high ozone values shown in Figure 2-6.

Along with the declining ozone levels, it can be seen that the WNNA has generally been in a NO_x limited regime, represented as greater peak weekday ozone when compared to weekend ozone. This region is in close proximity to biogenic ROG emissions sources and farther away from the large anthropogenic NO_x sources in the SFNA, such that low NO_x and high ROG conditions are prevalent, which is consistent with a NO_x-limited regime. The occasional shift in weekday/weekend ozone levels closer to the 1:1 dashed line (and in some years crossing over the line) is likely due to interannual variability in meteorological conditions and its impact on the regional transport patterns and local biogenic ROG emissions.

REFERENCES

Bao, J.W., Michelson, S.A., Persson, P.O.G., Djalalova, I.V., and Wilczak, J.M., 2008, Observed and WRF-simulated low-level winds in a high-ozone episode during the Central California Ozone Study, Journal of Applied Meteorology and Climatology, 47(9), 2372-2394.

Beaver, M.R. et al., 2012 Importance of biogenic precursors to the budget of organic nitrates: observations of multifunctional organic nitrates by CIMS and TD-LIF during BEARPEX 2009, Atmos. Chem. Phys., 12, 5773-5785.

Beaver, S.; Palazoglu, A. 2009. Influence of synoptic and mesoscale meteorology on ozone pollution potential for San Joaquin Valley of California. Atmos. Environ. 43: 1779–1788.

Blanchard, C.L.; Tanenbaum, S.; Fujita, E.M.; Campbell, D.; Wilkinson, J. August 2008. Understanding Relationships between Changes in Ambient Ozone and Precursor Concentrations and Changes in VOC and NOx Emissions from 1990 to 2004 in Central California

Bouvier-Brown, N. C., Goldstein, A. H., Gilman, J. B., Kuster, W. C., and de Gouw, J. A.: In-situ ambient quantification of monoterpenes, sesquiterpenes, and related oxygenated compounds during BEARPEX 2007: implications for gas- and particle-phase chemistry, Atmos. Chem. Phys., 9, 5505-5518, doi:10.5194/acp-9-5505-2009, 2009.

Cai C. et al., 2016 Simulating reactive nitrogen, carbon monoxide, and ozone in California during ARCTAS-CARB 2008 with high wildfire activity, Atmos. Environ. 128, 28-44.

CAPCOA (2015) California's Progress Toward Clean Air available at http://www.capcoa.org/wp-content/uploads/2015/04/2015%20PTCA%20CAPCOA%20Report%20-%20FINAL.pdf

CARB: (1989) "Proposed Identification of Districts Affected by Transported Air Pollutants which Contribute to Violations of the State Ambient Air Quality Standard for Ozone." Staff Report prepared by the Technical Support Division of theCalifornia Air Resources Board, October 1989 available at https://www.arb.ca.gov/aqd/transport/assessments/1989.pdf

CARB, (1990): Assessment and Mitigation of the Impacts of Transported Pollutants on Ozone Concentrations within California, Staff Report prepared by the Technical Support Division and the Office of Air Quality Planning and Liaison of the California Air Resources Board, June 1990 available at https://www.arb.ca.gov/aqd/transport/assessments/1990.pdf

CARB, (1993): Triennial Review of the Assessment and Mitigation of the Impacts of Transported Pollutants on Ozone Concentrations within California, Staff Report prepared by the Technical Support Division of the California Air Resources Board, June 1993 available at https://www.arb.ca.gov/aqd/transport/assessments/1993.pdf

CARB, (1996): Second Triennial Review of the Assessment and Mitigation of the Impacts of Transported Pollutants on Ozone Concentrations within California, Staff Report prepared by the Technical Support Division of the California Air Resources Board, November 1996 available at https://www.arb.ca.gov/regact/transpol/isor.pdf

CARB, (2001): Assessment of the Impacts of Transported Pollutants on Ozone Concentrations in California, Staff Report prepared by the Technical Support Division of the California Air Resources Board, March 2001 available at https://www.arb.ca.gov/regact/trans01/isor.pdf

Fast JD, WI Gustafson, Jr, LK Berg, WJ Shaw, MS Pekour, MKB Shrivastava, JC Barnard, R Ferrare, CA Hostetler, J Hair, MH Erickson, T Jobson, B Flowers, MK Dubey, PhD, SR Springston, BR Pirce, L Dolislager, JR Pederson, and RA Zaveri. 2012. "Transport and Mixing Patterns over Central California during the Carbonaceous Aerosol and Radiative Effects Study (CARES)." Atmospheric Chemistry and Physics 12(4):1759-1783. doi:10.5194/acp-12-1759-2012

Federal Register, 1997, Approval and Promulgation of Implementation Plans; California Ozone, Final Rule, January 8th, 1150-1187.

Federal Register, 2007, Treatment of Data Influenced by Exceptional Events; Final Rule", Final Rule, March 22nd, 13560-13581.

Federal Register, 2012, Determination of Attainment of the 1-Hour Ozone National Ambient Air Quality Standards in the Sacramento Metro Nonattainment Area in California, Final Rule, October 18th, 64036-64039.

Federal Register, 2014, Approval and Promulgation of Implementation Plans: State of California; Sacramento Metro Area; Attainment Plan for 1997 8-Hour Ozone Standard, Proposed Rule, October 15th, 61799-61822.

Fujita, E., D. Campbell, R. Keisler, J. Brown, S. Tanrikulu, and A. J. Ranzieri, 2001, Central California Ozone Study (CCOS)-Final report, volume III:Summary of field operations, Technical Report, California Air Resources Board, Sacramento.

Fujita, E., Keislar, R., Stockwell, W., Moosuller, H., DuBois, D., Koracin, D. and Zielinska, B. Central California Ozone Study-Volume I, Field Study Plan.Division of Atmospheric Science Desert Research Institue, 2215 Raggio Parkway, Reno, NV. 1999

Gentner, D.R. et al., 2014a, Emissions of organic carbon and methane from petroleum and dairy operations in California's San Joaquin Valley Atmos. Chem. Phys., 14, 4955-4978.

Gentner, D.R., Ormeño, Fares, E.S., Ford, T.B., Weber, R., Park, J.-H., Brioude, J., Angevine, W.M., Karlik, J.F., and Goldstein, A.H., 2014b, Emissions of terpenoids, benzenoids, and other biogenic gas-phase organic compounds from agricultural crops and their potential implications for air quality Atmos. Chem. Phys., 14, 5393–5413.

Heuss, J.M., Kahlbaum, D.F., and Wolff, G.T., 2003. Weekday/weekend ozone differences: What can we learn from them? Journal of the Air & Waste Management Association 53(7), 772-788.

Huang, M., Carmichael, G.R., Adhikary, B., Spak, S.N., Kulkarni, S., Cheng, Y.F., Wei, C., Tang, Y., Parrish, D.D., Oltmans, S.J., D'Allura, A., Kaduwela, A., Cai, C., Weinheimer, A.J., Wong, M., Pierce, R.B., Al-Saadi, J.A. Streets, D.G., and Zhang, Q., 2010, Impacts of transported background ozone on California air quality during the ARCTAS-CARB period - a multi-scale modeling study, Atmospheric Chemistry and Physics, 10(14), 6947-6968.

Jin, L., Harley, R.A., and Brown, N.J., 2011, Ozone pollution regimes modeled for a summer season in California's San Joaquin Valley: A cluster analysis, Atmospheric Environment, 45, 4707-4719.

LaFranchi, B. W., Goldstein, A. H., and Cohen, R. C.: Observations of the temperature dependent response of ozone to NO_x reductions in the Sacramento, CA urban plume, Atmos. Chem. Phys., 11, 6945-6960, doi:10.5194/acp-11-6945-2011, 2011

LaFranchi, B.W. et al., 2009, Closing the peroxy acetyl nitrate budget: observations of acyl peroxy nitrates (PAN, PPN, and MPAN) during BEARPEX 2007, Atmos. Chem. Phys., 9, 7623–7641.

Lehrman, D., B.Knuth and D.Fairley, 2001. Characterization of the 2000 Measurement Period, Interim Report, Contract No. 01-2CCOS, Technical and Business Systems, Inc., November.

Lehrman, D., Bush, D., Knuth, B., Fairley, D., Blanchard, C., 2004. Characterization of the CCOS 2000 measurement period. Final report, California Air Resources Board, Sacramento, CA, available at http://www.arb.ca.gov/airways/ccos/ccos.htm (item II-8).

Lin, Y.L., and Jao, I.C., 1995, A Numerical Study of Flow Circulations in the Central Valley of California and Formation Mechanisms of the Fresno Eddy, Monthly Weather Review, 123(11), 3227-3239.

Misztal, P. K., Avise, J. C., Karl, T., Scott, K., Jonsson, H. H., Guenther, A. B., and Goldstein, A. H.: Evaluation of regional isoprene emission factors and modeled fluxes in California, Atmos. Chem. Phys., 16, 9611-9628, doi:10.5194/acp-16-9611-2016, 2016.

Murphy, J. G., Day, D. A., Cleary, P. A., Wooldridge, P. J., Millet, D. B., Goldstein, A. H., and Cohen, R. C.: The weekend effect within and downwind of Sacramento – Part 1: Observations of ozone, nitrogen oxides, and VOC reactivity, Atmos. Chem. Phys., 7, 5327-5339, doi:10.5194/acp-7-5327-2007, 2007

NOAA (2014), Synthesis of Policy Relevant Findings from the CalNex 2010 Field Study, Final report to the California Air Resources Board, available at http://www.esrl.noaa.gov/csd/projects/calnex/synthesisreport.pdf

Pun, B.K., J.F. Louis and C. Seigneur, 2008. A conceptual model of ozone formation in the San Joaquin Valley. Doc. No. CP049-1-98. Atmospheric and Environmental Research Inc., San Ramon, CA, 15 December.

Pusede, S. E., and R. C. Cohen, 2012, On the observed response of ozone to NOx and VOC reactivity reductions in San Joaquin Valley California 1995–present, Atmos. Chem. Phys., 12, 8323–8339.

Pusede, S. E., Gentner, D. R., Wooldridge, P. J., Browne, E. C., Rollins, A. W., Min, K.-E., Russell, A. R., Thomas, J., Zhang, L., Brune, W. H., Henry, S. B., DiGangi, J. P., Keutsch, F. N., Harrold, S. A., Thornton, J. A., Beaver, M. R., St. Clair, J. M., Wennberg, P. O., Sanders, J., Ren, X., VandenBoer, T. C., Markovic, M. Z., Guha, A., Weber, R., Goldstein, A. H., and Cohen, R. C.: On the temperature dependence of organic reactivity, nitrogen oxides, ozone production, and the impact of emission controls in San Joaquin Valley, California, Atmos. Chem. Phys., 14, 3373-3395, doi:10.5194/acp-14-3373-2014, 2014.

Roberts, P.T., C.G. Lindsey and E.M. Prins (1990). "1990 Field Operations Plan: Sacramento Area Ozone Study." Sonoma Technology Inc. Report #STI-90042-1015 prepared for Systems Applications, Inc. and the Sacramento Area Council of Governments, Santa Rosa, CA.

Seinfeld J. H. and Pandis S. N. (1998) Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, 1st edition, J. Wiley, New York.

Smith, T.B, D.E. Lehrman, D.D. Reible, and F.H. Shair (1981): A Study of the Origin and Fate of Air Pollutants in California's Sacramento Valley, Final Report to the California Air Resources Board, December 1981.

Solomon, P.A. and Magliano, K.L., 1998, The 1995-Integrated Monitoring Study (IMS95) of the California Regional PM10/PM2.5 air quality study (CRPAQS): Study overview, Atmospheric Environment, 33(29), 4747-4756.

U.S. EPA, (2012) 2008 Ground-Level Ozone Standards - Final Designations https://www3.epa.gov/region9/air/ozone/pdf/R9_CA_AllTechAnalyses_FINAL2.pdf

Zhong, Shiyuan, C. David Whiteman, Xindi Bian, 2004: Diurnal Evolution of Three-Dimensional Wind and Temperature Structure in California's Central Valley. J. Appl. Meteor., 43, 1679–1699.

Appendix H

Photochemical Modeling Protocol: Photochemical Modeling for the 8-Hour Ozone and Annual/24-hour PM2.5 State Implementation Plans

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

August 31, 2018

TABLE OF CONTENTS

1. **INTRODUCTION** **10**

1.1 Modeling roles for the current SIP 10

1.2 Stakeholder participation 10

1.3 Involvement of external scientific/technical experts and their input on the photochemical modeling 10

1.4 Schedule for completion of the Plan 12

2. **DESCRIPTION OF THE CONCEPTUAL MODEL FOR THE NONATTAINMENT AREA** **12**

3. **SELECTION OF MODELING PERIODS** **12**

3.1 Reference Year Selection and Justification 12

3.2 Future Year Selection and Justification 13

3.3 Justification for Seasonal/Annual Modeling Rather than Episodic Modeling 14

4. **DEVELOPMENT OF EMISSION INVENTORIES** **14**

5. **MODELS AND INPUTS** **15**

5.1 Meteorological Model 15

5.1.1Meteorological Modeling Domain 15

5.2 Photochemical Model 18

5.2.1Photochemical Modeling Domain 19

5.2.2CMAQ Model Options 22

5.2.3Photochemical Mechanism 22

5.2.4Aerosol Module 23

5.2.5CMAQ Initial and Boundary Conditions (IC/BC) and Spin-Up period 23

5.3 Quality Assurance of Model Inputs 25

6. **METEOROLOGICAL MODEL PERFORMANCE** **26**

6.1 Ambient Data Base and Quality of Data 26

6.2 Statistical Evaluation 26

6.3 Phenomenological Evaluation 27

7. **PHOTOCHEMICAL MODEL PERFORMANCE** **28**

7.1 Ambient Data 28

7.2 Statistical Evaluation 29

7.3 Comparison to Previous Modeling Studies 31

7.4 Diagnostic Evaluation 31

8. ATTAINMENT DEMONSTRATION 32

8.1 Base Year Design Values 32

8.2 Base, Reference, and Future Year Simulations 33

8.3 Relative Response Factors 34

8.3.18-hour Ozone RRF 34

8.3.2Annual and 24-hour $PM_{2.5}$ RRF 35

8.4 Future Year Design Value Calculation 35

8.4.18-hour Ozone 35

8.4.2Annual and 24-hour $PM_{2.5}$ 36

8.5 Unmonitored Area Analysis 42

8.5.18-hour Ozone 42

8.5.2Annual $PM_{2.5}$ 43

8.5.324-hour $PM_{2.5}$ 43

8.6 Banded Relative Response Factors for Ozone 44

9. PROCEDURAL REQUIREMENTS 44

9.1 How Modeling and other Analyses will be Archived, Documented, and Disseminated 44

9.2 Specific Deliverables to U.S. EPA 45

REFERENCES 45

LIST OF FIGURES

Figure 5-1. The three nested grids for the WRF model (D01 36km; D02 12km; and D03 4km). 16

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 the 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. 21

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). 24

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. 35

LIST OF TABLES

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. 13

Table 5-1. WRF vertical layer structure. 17

Table 5-2. WRF Physics Options. 17

Table 5-3. CMAQ v5.0.2 configuration and settings. 22

Table 7-1. Monitored species used in evaluating model performance. 28

Table 8-1. Illustrates the data from each year that are utilized in the Design Value calculation for that year (DV Year), and the yearly weighting of data for the weighted Design Value calculation (or DV_R). "obs" refers to the observed metric (8-hr O_3, 24-hour $PM_{2.5}$, or annual average $PM_{2.5}$). 33

ACRONYMS

ARB – Air Resources Board

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

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 Model

3. 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.

3.1 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.

ARB and local Air Districts jointly develop the emission inventories, which are an integral part of the modeling. Working closely with the Districts, the ARB 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 ARB, the SIP will be submitted to U.S.EPA for approval.

3.2 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 ARB 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 ARB 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.

3.3 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), ARB 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 – ARB
	Samir Sheikh – SJVAPCD
Members:	Scott Bohning – U.S. EPA Region 9
	Ajith Kaduwela – ARB
	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 ARB 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.

3.4 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 ARB Board 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.

4. 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).

5. SELECTION OF MODELING PERIODS

5.1 Reference Year Selection and Justification

From an air quality and emissions perspective, ARB and the Districts have selected 2012 as the base year for design value 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 design values.

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 $PM_{2.5}$ design values for year 2013 were some of the highest in recent years, making 2013 a conservative choice for attainment demonstration modeling.

Details and discussion on these analyses can be found in the Weight of Evidence Appendix.

5.2 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

5.3 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.

6. 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.

7. MODELS AND INPUTS

7.1 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 ARB 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.

7.1.1 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.

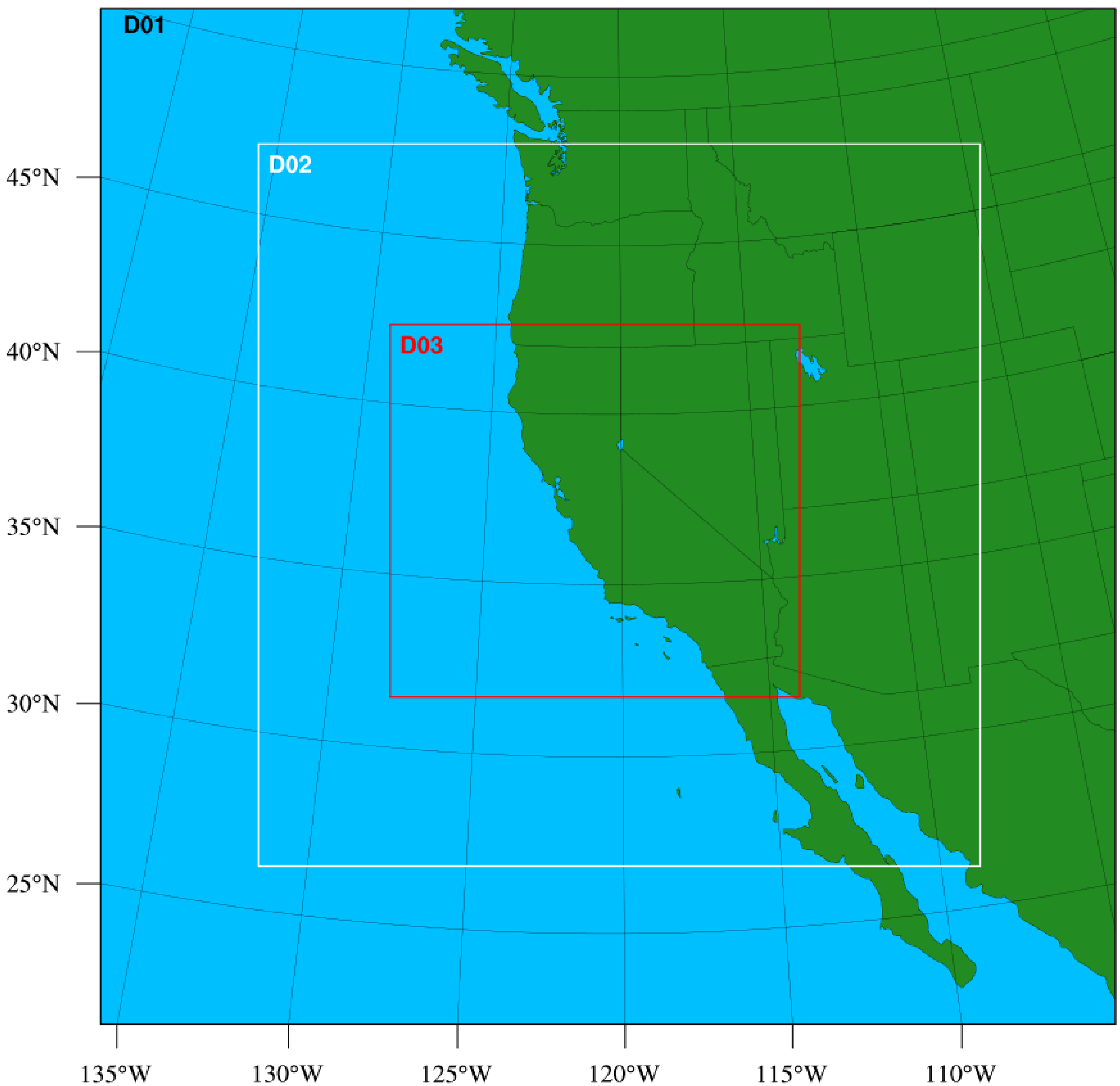


Figure 7-1. The three nested grids for the WRF model (D01 36km; D02 12km; and D03 4km).

Table 7-1. 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 7-2. 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

7.2 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/$PM_{2.5}$ 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 ARB'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).

7.2.1 Photochemical Modeling Domain

Figure 5-2 shows the photochemical modeling domains used by ARB 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 ARB’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.

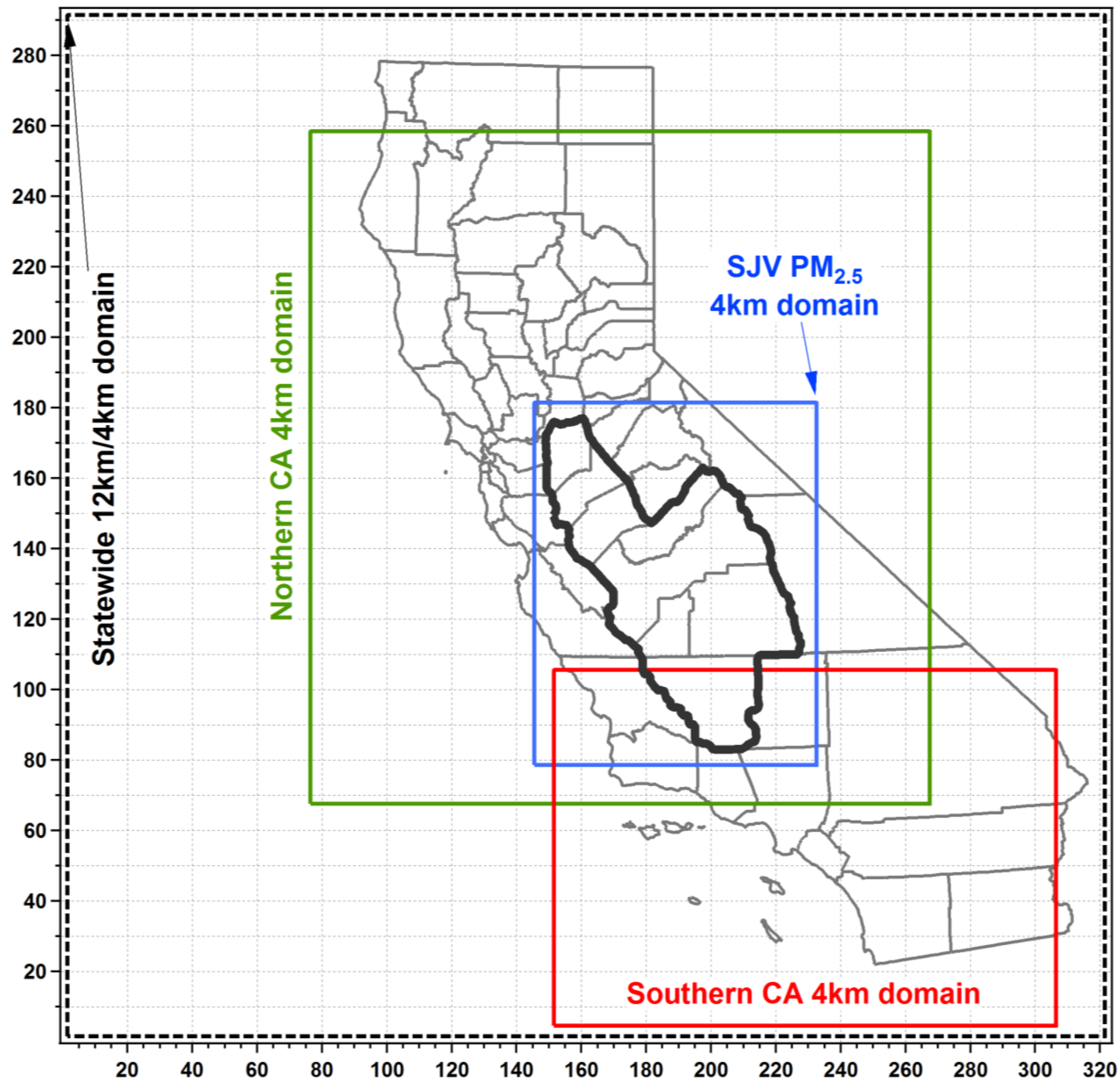


Figure 7-2. CMAQ modeling domains used in this SIP modeling platform. The outer domain (dashed black line) represents the extent of the California statewide domain (shown here with a 4 km horizontal resolution, but utilized in this modeling platform with a 12 km horizontal resolution). Nested higher 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.

7.2.2 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 7-3. 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)

7.2.3 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 ARB 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.

7.2.4 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).

7.2.5 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 ARB 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 ARB’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).

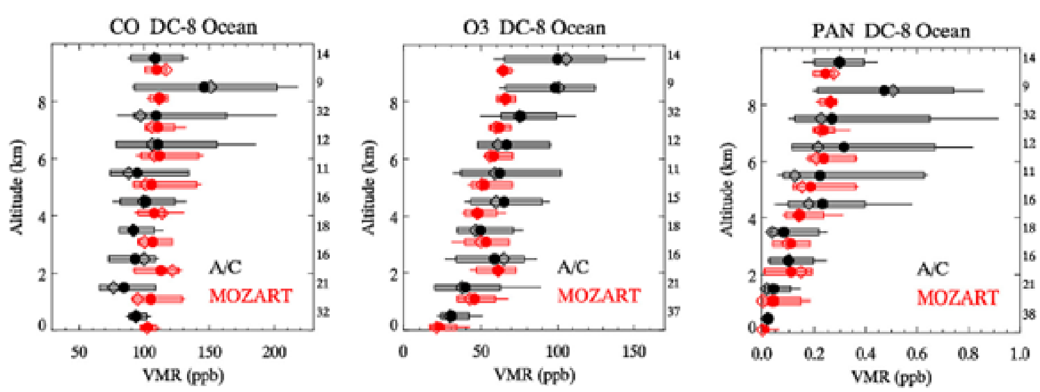


Figure 7-3. Comparison of MOZART (red) simulated CO (left), ozone (center), and PAN (right) to observations (black) along the DC-8 flight track. Shown are mean (filled symbol), median (open symbols), 10th and 90th percentiles (bars) and extremes (lines). The number of data points per 1-km wide altitude 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).

7.3 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.

8. 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.

8.1 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 ARB also has quality-assured upper-air meteorological data obtained using balloons, aircraft, and profilers.

8.2 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 ARB. 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:

$$MB = \frac{1}{N}\sum_{1}^{N}(\mathrm{Model} - \mathrm{Obs}) \qquad (6\text{-}1)$$

$$ME = \frac{1}{N}\sum_{1}^{N}\left|Model - Obs\right| \quad (6\text{-}2)$$

$$NMB = \frac{\sum_{1}^{N}(Model - Obs)}{\sum_{1}^{N} Obs} \times 100\%, \quad (6\text{-}3)$$

$$RSME = \sqrt{\frac{\sum_{1}^{N}(Model - Obs)^2}{N}} \quad (6\text{-}4)$$

$$IOA = 1 - \frac{\sum_{1}^{N}(Model - Obs)^2}{\sum_{1}^{N}\left[(Model - Obs) + (Model + Obs)\right]^2}, \quad (6\text{-}5)$$

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.

8.3 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.

9. PHOTOCHEMICAL MODEL PERFORMANCE

9.1 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).

9.2 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.

$$\mathrm{MB} = \frac{1}{\mathrm{N}}\sum_{1}^{\mathrm{N}}(\mathrm{Model} - \mathrm{Obs}) \quad (7\text{-}1)$$

$$\mathrm{ME} = \frac{1}{\mathrm{N}}\sum_{1}^{\mathrm{N}}\left|\mathrm{Model} - \mathrm{Obs}\right| \qquad (7\text{-}2)$$

$$\mathrm{MFB} = \frac{2}{\mathrm{N}}\sum_{1}^{\mathrm{N}}\left(\frac{\mathrm{Model} - \mathrm{Obs}}{\mathrm{Model} + \mathrm{Obs}}\right) \times 100\%, \qquad (7\text{-}3)$$

$$\mathrm{MFE} = \frac{2}{\mathrm{N}}\sum_{1}^{\mathrm{N}}\left(\frac{\left|\mathrm{Model} - \mathrm{Obs}\right|}{\mathrm{Model} + \mathrm{Obs}}\right) \times 100\%, \qquad (7\text{-}4)$$

$$\mathrm{NMB} = \frac{\sum_{1}^{\mathrm{N}}(\mathrm{Model} - \mathrm{Obs})}{\sum_{1}^{\mathrm{N}}\mathrm{Obs}} \times 100\%, \qquad (7\text{-}5)$$

$$\mathrm{NME} = \frac{\sum_{1}^{\mathrm{N}}\left|\mathrm{Model} - \mathrm{Obs}\right|}{\sum_{1}^{\mathrm{N}}\mathrm{Obs}} \times 100\%, \qquad (7\text{-}6)$$

$$\mathrm{RSME} = \sqrt{\frac{\sum_{1}^{\mathrm{N}}(\mathrm{Model} - \mathrm{Obs})^2}{\mathrm{N}}} \qquad (7\text{-}7)$$

$$\mathrm{R}^2 = \left(\frac{\sum_{1}^{\mathrm{N}}((\mathrm{Model} - \overline{\mathrm{Model}}) \times (\mathrm{Obs} - \overline{\mathrm{Obs}}))}{\sqrt{\sum_{1}^{\mathrm{N}}(\mathrm{Model} - \overline{\mathrm{Model}})^2 \sum_{1}^{\mathrm{N}}(\mathrm{Obs} - \overline{\mathrm{Obs}})^2}}\right)^2 \qquad (7\text{-}8)$$

$$\mathrm{MNB} = \frac{1}{\mathrm{N}}\sum_{1}^{\mathrm{N}}\left(\frac{\mathrm{Model} - \mathrm{Obs}}{\mathrm{Obs}}\right) \times 100\%, \qquad (7\text{-}9)$$

$$\text{MNGE} = \frac{1}{N}\sum_{1}^{N}\left(\frac{|\text{Model} - \text{Obs}|}{\text{Obs}}\right)\times 100\%. \quad (7\text{-}10)$$

where, “Model” is the simulated mixing ratio, “$\overline{\text{Model}}$” is the simulated mean mixing ratio, “Obs” is the observed value, “$\overline{\text{Obs}}$” 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.

9.3 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.

9.4 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).

10. 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.

10.1 Base Year Design Values

The starting point for the attainment demonstration is with the observational based design value (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 10-1. Illustrates the data from each year that are utilized in the Design Value calculation for that year (DV Year), and the yearly weighting of data for the weighted Design Value 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 Design Value (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 Design Value Calculation				
2012-2014 Average	$DV_R = \frac{obs_{2010} + (2)obs_{2011} + (3)obs_{2012} + (2)obs_{2013} + obs_{2014}}{9}$				

10.2 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.

10.3 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).

$$\text{RRF} = \frac{\text{average } (O_3 \text{ or } PM_{2.5})_{\text{future}}}{\text{average } (O_3 \text{ or } PM_{2.5})_{\text{reference}}} \quad (8\text{-}1)$$

10.3.1 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.

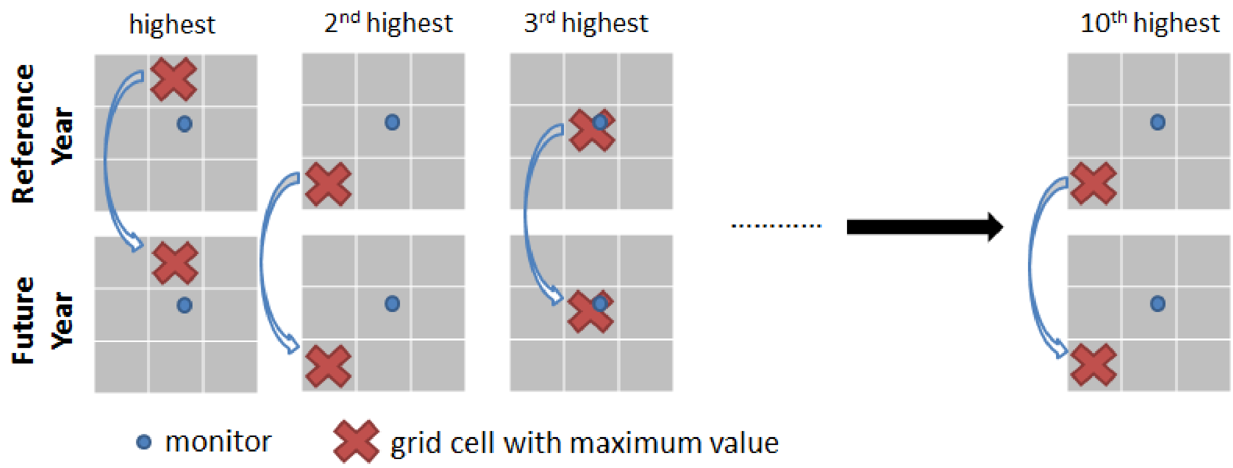


Figure 10-1. Example showing how the location of the MDA8 ozone for the top ten days in the reference and future years are chosen.

10.3.2 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).

10.4 Future Year Design Value Calculation

10.4.1 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).

$$DV_F = DV_R \times RRF \quad (8\text{-}2)$$

where,
DV_F = future year design value,
DV_R = reference year design value, 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 design value does not exceed the level of the standard.

10.4.2 Annual and 24-hour $PM_{2.5}$

10.4.2.1 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.

10.4.2.2 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)).

10.4.2.3 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 design value 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 design value 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 design value at each site based on the 98^{th} percentile concentrations calculated in Step 5 and following the standard protocol for calculating design values (see Table 8-1). Compare the future-year 24-hour design values to the NAAQS. If the projected design value is ≤ the NAAQS, then the attainment test is passed.

10.4.2.4 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 design value 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 design values 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 design value) 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.

10.5 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 design value 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 design values. The spatial Interpolation of the observed design values 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 ARB 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.

10.5.1 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.

10.5.2 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 $PM_{2.5}$ design values 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.

10.5.3 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 $PM_{2.5}$ design values 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.

10.6 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 design value 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 design value is calculated in a manner consistent with the base/reference year design value 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).

11. PROCEDURAL REQUIREMENTS

11.1 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 ARB can determine the capacity of the external disk drive(s) that the requester should send.

11.2 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 Design Values
- Access to input data and simulation results

REFERENCES

Abt, 2014. Modeled Attainment Test Software: User's Manual. MATS available at: http://www.epa.gov/scram001/modelingapps_mats.htm

Angevine, W.M., Eddington, L., Durkee, K., Fairall, C., Bianco, L., and Brioude, J., 2012, Meteorological model evaluation for CalNex 2010, Monthly Weather Review, 140, 3885-3906.

Ansari, A.S., and Pandis, S.N., 1998, Response of inorganic PM to precursor concentrations, Environmental Science & Technology, 32, 2706-2714.

Appel, K. W., Pouliot, G. A., Simon, H., Sarwar, G., Pye, H. O. T., Napelenok, S. L., Akhtar, F., and Roselle, S. J., 2013, Evaluation of dust and trace metal estimates from the Community Multiscale Air Quality

(CMAQ) model version 5.0, Geoscientific Model Development, 6, 883-899, doi:10.5194/gmd-6-883-2013, 2013.

Appel, W. K., Gilliland, A.B., Sarwar, G., and Gilliam, R.C., 2007, Evaluation of the Community Multiscale Air Quality (CMAQ) model version 4.5: Sensitivities impacting model performance: Part I – Ozone, Atmospheric Environment, 41, 9603-9615.

Appel, W.K., Bhave, P.V., Gilliland, A.B., Sarwar, G., and Roselle, S.J., 2008, Evaluation of the Community Multiscale Air Quality (CMAQ) model version 4.5: Sensitivities impacting model performance; Part II – Particulate Matter, Atmospheric Environment, 42, 6057-6066.

Avise, J., Chen, J., Lamb, B., Wiedinmyer, C., Guenther, A., Salathe, E., and Mass, C., 2009, Attribution of projected changes in summertime US ozone and $PM_{2.5}$ concentrations to global changes, Atmospheric Chemistry and Physics, 9, 1111-1124.

Azzi, M., White, S.J., Angove, D.E., Jamie, I. M., and Kaduwela, A., 2010, Evaluation of the SAPRC-07 mechanism against CSIRO smog chamber data, Atmospheric Environment, 44, 1707-1713.

Baker, K. R., Carlton, A. G., Kleindienst, T. E., Offenberg, J. H., Beaver, M. R., Gentner, D. R., Goldstein, A. H., Hayes, P. L., Jimenez, J. L., Gilman, J. B., de Gouw, J. A., Woody, M. C., Pye, H. O. T., Kelly, J. T., Lewandowski, M., Jaoui, M., Stevens, P. S., Brune, W. H., Lin, Y.-H., Rubitschun, C. L., and Surratt, J. D.: Gas and aerosol carbon in California: comparison of measurements and model predictions in Pasadena and Bakersfield, Atmos. Chem. Phys., 15, 5243-5258, doi:10.5194/acp-15-5243-2015, 2015.

Bao, J.W., Michelson, S.A., Persson, P.O.G., Djalalova, I.V., and Wilczak, J.M., 2008, Observed and WRF-simulated low-level winds in a high-ozone episode during the Central California Ozone Study, Journal of Applied Meteorology and Climatology, 47(9), 2372-2394.

Binkowski, F.S. and Roselle, S.J., 2003, Models-3 Community Multiscale Air Quality (CMAQ) model aerosol component, 2. Model description, Journal of Geophysical Research, 108, D6, doi:10.1029/2001jd001409.

Borge, R., Lopez, J., Lumbreras, J., Narros, A., and Rodriguez, E., 2010, Influence of boundary conditions on CMAQ simulations over the Iberian Peninsula, Atmospheric Environment, 44, 2681-2695 (doi:10.1016/j.atmosenv.2010.04.044).

Boylan, J.W., Russell, A.G., (2006), PM and light extinction model performance metrics, goals, and criteria for three-dimensional air quality models. Atmospheric Environment 40, 4946-4959.

Brown, N., Allen,D.T., Amar, P., Kallos, G., McNider, R., Russell, A.G., and Stockwell, W.R., 2011, Final report: Fourth peer review of the CMAQ model, Submitted to Community Modeling and Analysis System Center, The University of North Carolina at Chapel Hill.

Byun, D.W. and Ching, J.K.S., 1999, Science Algorithms of the EPA Models-3 Community Multiscale Air Quality (CMAQ) Modeling System, EPA/600/R-99/030, available at http://www.epa.gov/AMD/CMAQ/CMAQscienceDoc.html

Byun, D.W. and Schere, K.L., 2006, Review of the governing equations, computational algorithms, and other components of the Models-3 Community Multiscale Air Quality (CMAQ) modeling system, Applied Mechanics Review, 59, 51-77.

Cai, C., Kelly, J.T., Avise, J.C., Kaduwela, A.P., and Stockwell, W.R., 2011, Photochemical modeling in California with two chemical mechanisms: Model intercomparison and response to emission reductions, Journal of the Air & Waste Management Association, 61, 559-572.

Carlton, A.G., Bhave, P., Napelenok, S.L., Edney, E.O., Sarwar, G., Pinder, R.W., Pouliot, G.A., and Houyoux, M., 2010, Model representation of secondary organic aerosol in CMAQv4.7, Environmental Science Technology, 44, 8553-8560.

Carter, W.P.L., 2010a, Development of the SAPRC-07 chemical mechanism, Atmospheric Environment, 44(40), 5324-5335.

Carter, W.P.L., 2010b, Development of a condensed SAPRC-07 chemical mechanism, Atmospheric Environment, 44(40), 5336-5345.

Chen, J., Vaughan, J., Avise, J., O'Neill, S., and Lamb, B., 2008, Enhancement and evaluation of the AIRPACT ozone and $PM_{2.5}$ forecast system for the Pacific Northwest, Journal of Geophysical Research, 113, D14305, doi:10.1029/2007JD009554.

Chen, J., Avise, J., Guenther, A., Wiedinmyer, C., Salathe, E., Jackson, R.B., and Lamb, B., 2009a, Future land use and land cover influences on regional biogenic emissions and air quality in the United States, Atmospheric Environment, 43, 5771-5780.

Chen, J., Avise, J., Lamb, B., Salathe, E., Mass, C., Guenther, A., Wiedinmyer, C., Lamarque, J.-F., O'Neill, S., McKenzie, D., and Larkin, N., 2009b, The effects fo global changes upon regional ozone pollution in the United States, Atmospheric Chemistry and Physics, 9, 1125-1141.

Chen, J., Lu, J., Avise, J.C., DaMassa, J.A., Kleeman, M.J., and Kaduwela, A.P., 2014, Seasonal modeling of PM2.5 in California's San Joaquin Valley, Atmospheric Environment, 92, 182-190.

Chow J.C., Watson, J.G., Lowenthal, D.H., and Magliano, K., 2005, Loss of PM2.5 nitrate from filter samples in Central California, Journal of Air & Waste Management Association, 55, 1158-1168.

Civerolo, K., Hogrefe, C., Zalewsky, E., Hao, W., Sistla, G., Lynn, B., Rosenzweig, C., and Kinney, P., 2010, Evaluation of an 18-year CMAQ simulation: Seasonal variations and long-term temporal changes in sulfate and nitrate, Atmospheric Environment, 44, 3745-3752.

Dennis, R.L., Bhave, P., and Pinder, R.W., 2008, Observable indicators of the sensitivity of PM2.5 nitrate to emission reductions – Part II: Sensitivity to errors in total ammonia and total nitrate of the CMAQ-predicted non-linear effect of SO2 emission reductions, Atmospheric Environment, 42, 1287-1300.

Derwent, R. G., M. E. Jenkin, M. J. Pilling, W.P.L. Carter, and A. Kaduwela, 2010, Reactivity scales as comparative tools for chemical mechanisms, Journal of the Air & Waste Management Association, 60, 914-924.

Eder, B., Yu, S., 2006, A performance evaluation of the 2004 release of Models-3 CMAQ, Atmospheric Environment, 40, 4811-4824.

Emery, C., Tai, E., and Yarwood, G., 2001, Enhanced Meteorological Modeling and Performance Evaluation for Two Texas Ozone Episodes, Final report submitted to the Texas Natural Resources Conservation Commission.

Emmons, L.K., Walters, S., Hess, P.G., Lamarque, J.F., Pfister, G.G., Fillmore, D., Granier, C., Guenther, A., Kinnison, D., Laepple, T., Orlando, J., Tie, X., Tyndall, G., Wiedinmyer, C., Baughcum, S.L., and Kloster, S., 2010, Description and evaluation of the Model for Ozone and Related chemical Tracers, Version 4 (MOZART-4), Geoscientific Model Development, 3, 43-67.

Ensberg, J. J., et al., 2013, Inorganic and black carbon aerosols in the Los Angeles Basin during CalNex, Journal of Geophysical Research - Atmosphere, 118, 1777–1803, doi:10.1029/2012JD018136.

Fast, J.D., et al., 2014, Modeling regional aerosol and aerosol precursor variability over California and its sensitivity to emissions and long-range transport during the 2010 CalNex and CARES campaigns, Atmospheric Chemistry Physics, 14, 10013-10060.

Foley, K.M., Roselle, S.J., Appel, K.W., Bhave, P.V., Pleim, J.E., Otte, T.L., Mathur, R., Sarwar, G., Young, J.O., Gilliam, R.C., Nolte, C.G., Kelly, J.T., Gilliland, A.B., and Bash, J.O., 2010, Incremental testing of the Community Multiscale Air Quality (CMAQ) modeling system version 4.7, Geoscientific Model Development, 3, 205-226.

Fountoukis, C. and Nenes, A., 2007, ISORROPIA II: a computationally efficient thermodynamic equilibrium model for K+–Ca2+–Mg2+–NH4+–Na+–SO42−–NO3−–Cl−–H2O aerosols, Atmospheric Chemistry Physics, 7, 4639-4659.

Frank, N.H., 2006, Retained nitrate, hydrated sulfates, and carbonaceous mass in federal reference method fine particulate matter for six eastern U.S. cities, Journal of Air & Waste Management Association, 56, 500-511.

Hakami, A., Bergin, M.S., and Russell, A.G., 2004a, Ozone formation potential of organic compounds in the eastern United States: A comparison of episodes, inventories, and domain, Environmental Science & Technology, 38, 6748-6759.

Hakami, A., Harley, R.A., Milford, J.B., Odman, M.T., and Russell, A.G., 2004b, Regional, three-dimensional assessment of the ozone formation potential of organic compounds, Atmospheric Environment, 38, 121-134.

Hering, S. and Cass, G. 1999, The magnitude of bias in measurement of PM2.5 arising from volatilization of particulate nitrate from Teflon filters, Journal of Air & Waste Management Association, 49, 725-733.

Hogrefe, C., Hao, W., Zalewsky, E.E., Ku, J.Y., Lynn, B., Rosenzweig, C., Schultz, M.G., Rast, S., Newchurch, M.J., Wang, L., Kinney, P.L., and Sistla, G., 2011, An analysis of long-term regional-scale ozone simulations over the Northeastern United States: variability and trends, Atmospheric Chemistry and Physics, 11, 567-582.

Hogrefe,C., Biswas, J., Lynn, B., Civerolo, K., Ku, J.Y., Rosenthal, J. , Rosenweig, C., Goldberg, R., and Kinney, P.L., 2004, Simulating regional-scale ozone climatology over the eastern United States: model evaluation results, Atmospheric Environment, 38, 2627-2638.

Hogrefe, C., S. T. Rao, I. G. Zurbenko, and P. S. Porter, 2000 *Interpreting Information in Time Series of Ozone Observations and Model Predictions Relevant to Regulatory Policies in the Eastern United States*. Bull. Amer. Met. Soc., 81, 2083 – 2106

Hu, J., Howard, C.J., Mitloehner, F., Green, P.G., and Kleeman, M.J., 2012, Mobile source and livestock feed contributions to regional ozone formation in Central California, Environmental Science & Technology, 46, 2781-2789.

Hu, J., Ying, Q., Chen, J., Mahmud, A., Zhao, Z., Chen, S.H., and Kleeman, M.J., 2010, Particulate air quality model predictions using prognostic vs. diagnostic meteorology in central California, Atmospheric Environment, 44, 215-226.

Hu,J., Zhang, H., Chen, S. , Ying, Q., Wiedinmyer, C., Vandenberghe, F., and Kleeman, M.J., 2014a, Identifying PM2.5 and PM0.1 sources for epidemiological studies in California, Environmental Sciences & Technology, 48, 4980-4990.

Hu, J., Zhang, H., Ying, Q., Chen, S.-H., Vandenberghe, F., and Kleeman, M. J., 2014b, Long-term particulate matter modeling for health effects studies in California – Part 1: Model performance on temporal and spatial variations, Atmospheric Chemistry Physics Discussion, 14, 20997-21036.

Huang, M., Carmichael, G.R., Adhikary, B., Spak, S.N., Kulkarni, S., Cheng, Y.F., Wei, C., Tang, Y., Parrish, D.D., Oltmans, S.J., D'Allura, A., Kaduwela, A., Cai, C., Weinheimer, A.J., Wong, M., Pierce, R.B., Al-Saadi, J.A. Streets, D.G., and Zhang, Q., 2010, Impacts of transported background ozone on California air quality during the ARCTAS-CARB period - a multi-scale modeling study, Atmospheric Chemistry and Physics, 10(14), 6947-6968.

Jackson, B., Chau, D., Gürer, K., and Kaduwela, A, 2006, Comparison of ozone simulations using MM5 and CALMET/MM5 hybrid meteorological fields for the July/August 2000 CCOS episode, Atmospheric Environment, 40, 2812-2822.

Jacob, D.J., Crawford, J.H., Maring, H., Clarke, A.D., Dibb, J.E., Emmons, L.K., Ferrare, R.A., Hostetler, C.A., Russell, P.B., Singh, H.B., Thompson, A.M., Shaw, G.E., McCauley, E., Pederson, J.R., and Fisher, J.A., 2010, The Arctic Research of the Composition of the Troposphere from Aircraft and Satellites (ARCTAS) Mission: Design, Execution, and First Results, Atmospheric Chemistry and Physics, 10(11), 5191-5212.

Jathar, S. H., Cappa, C. D., Wexler, A. S., Seinfeld, J. H., and Kleeman, M. J.: Multi-generational oxidation model to simulate secondary organic aerosol in a 3-D air quality model, Geosci. Model Dev., 8, 2553-2567, doi:10.5194/gmd-8-2553-2015, 2015.

Jin L., Brown, N.J., Harley, R.A., Bao, J.W., Michelson, S.A., and Wilczak, J.M., 2010b, Seasonal versus episodic performance evaluation for an Eulerian photochemical air quality model, Journal of Geophysical Research, 115, D09302, doi:10.1029/2009JD012680.

Jin, L. Brown, N. and Harley, R.A. A Seasonal Perspective on Regional Air Quality in Central California, Draft Final Report, Lawrence Berkeley National Laboratory, Berkeley, CA, January, 2010a.

Jin, L., Tonse, S., Cohan, D.S., Mao, X., Harley, R.A., and Brown, N.J., 2008, Sensitivity analysis of ozone formation and transport for a central California air pollution episode, Environmental Science Technology, 42, 3683-3689.

Kelly, J. T., et al., 2014, Fine-scale simulation of ammonium and nitrate over the South Coast Air Basin and San Joaquin Valley of California during CalNex-2010, Journal of Geophysical Research - Atmosphere, 119, 3600–3614, doi:10.1002/2013JD021290.

Kelly, J.T., Avise, J., Cai, C., and Kaduwela, A., 2010b, Simulating particle size distributions over California and impact on lung deposition fraction, Aerosol Science & Technology, 45, 148-162.

Kelly, J.T., Bhave, P., Nolte, C.G., Shankar, U., and Foley, K.M., 2010a, Simulating emission and chemical evolution of coarse sea-salt particles in the Community Multiscale Air Quality (CMAQ) model, Geoscientific Model Development, 3, 257-273.

Kulkarni, S., Kaduwela, A.P., Avise, J.C., DaMassa, J.A., and Chau, D. , 2014, An extended approach to calculate the ozone relative response factors used in the attainment demonstration for the National Ambient Air Quality Standards, Journal of the Air & Waste Management Association, 64, 1204-1213.

Lam, Y.F. and Fu, J.S., 2009, A novel downscaling technique for the linkage of global and regional air quality modeling, Atmospheric Chemistry and Physics, 9, 9169-9185.

Lane, T.E., Donahue, N.M., and Pandis, S.N., 2008, Simulating secondary organic aerosol formation using the volatility basis-set approach in a chemical transport model, Atmospheric Environment, 42, 7439-7451.

Lee, S. H., Kim, S.W., Trainer, M., Frost, G.J., McKeen, S.A., Cooper, O.R., Flocke, F., Holloway, J.S., Neuman, J.A., Ryerson, T., Senff, C.J., Swanson, A.L., and Thompson, A.M., 2011, Modeling ozone plumes observed downwind of New York City over the North Atlantic Ocean during the ICARTT field campaign, Atmospheric Chemistry and Physics, 11, 7375-7397, doi:10.5194/acp-11-7375-2011.

Liang, J. and Kaduwela, A., 2005, Micro-development of CMAQ for California Regional Particulate Matter Air Quality Study, Proceedings of the 4^{th} Annual CMAQ Models-3 User's Conference, Chapel Hill, NC.

Lin, C. J., Ho, T. C., Chu, H. W.,, Yang, H., Chandru, S., Krishnarajanagar, N., Chiou, P., Hopper J. R., June 2005,Sensitivity analysis of ground-level ozone concentration to emission changes in two urban regions of southeast Texas, Journal of Environ. Manage., 75 315-323, http://dx.doi.org/10.1016/j.jenvman.2004.09.012.

Lin, M., Holloway, T., Carmichael, G.R., and Fiore, A.M., 2010, Quantifying pollution inflow and outflow over East Asia in spring with regional and global models, Atmospheric Chemistry and Physics, 10, 4221-4239, doi:10.5194/acp-10-4221-2010.

Lin, M., Holloway, T., Oki, T., Streets, D. G., and Richter, A., 2009, Multi-scale model analysis of boundary layer ozone over East Asia, Atmospheric Chemistry Physics, 9, 3277-3301, 2009.

Lin, M., Oki, T., Holloway, T., Streets, D.G., Bengtsson, M., and Kanae, S., 2008, Long-range transport of acidifying substances in East Asia - Part I: Model evaluation and sensitivity studies, Atmospheric Environment, 42, 5939-5955.

Livingstone, P.L., Magliano, K.,Guerer, K., Allen, P.D., Zhang, K.M., Ying, Q., Jackson, B.S., Kaduwela, A., Kleeman, M., Woodhouse, L.F., Turkiewicz, K., Horowitz, L.W., Scott, K., Johnson, D., Taylor, C., O'Brien, G., DaMassa, J., Croes, B.E., Binkowski, F., and Byun, D., 2009, Simulating PM concentration during a winter episode in a subtropical valley: Sensitivity simulations and evaluation methods, Atmospheric Environment, 43, 5971-5977.

Lu, W., Zhong, S., Charney, J.J., Bian, X., and Liu, S., 2012, WRF simulation over complex terrain during a southern California wildfire event, Climate and Dynamics, 117, D05125, doi:10.1029/2011JD017004.

Mahmud, A., Hixson, M., Hu, J., Zhao, Z., Chen, S.H., and Kleeman, M.J., 2010, Climate impact on airborne particulate matter concentrations in California using seven year analysis periods, Atmospheric Chemistry Physics, 10, 11097-11114.

Marmur, A., Park, S.K., Mulholland, J.A., Tolbert, P.E., and Russell, A.G., 2006, Source apportionment of PM2.5 in the southeastern United States using receptor and emissions-based models: Conceptual differences and implications for time-series health studies, Atmospheric Environment, 40, 2533-2551.

Michelson, S.A.,Djalalova, I.V.,and Bao, J.W., 2010, Evaluation of the Summertime Low-Level Winds Simulated by MM5 in the Central Valley of California, Journal of Applied Meteorology and Climatology, 49(11), 2230-2245.

Mollner, A.K., Valluvadasan, S., Feng, L., Sprague, M.K., Okumura, M., Milligan, D.B., Bloss, W.J., Sander, S.P., Martien, P.T., Harley, R.A., McCoy, A.B., and Carter, W.P.L., 2010, Rate of Gas Phase Association of Hydroxyl Radical and Nitrogen Dioxide, Sciences, 330, 646-649.

Morris, R.E., Koo, B., Guenther, A., Yarwood, G., McNally, D., Tesche, T.W., Tonnesen, G., Boylan, J., Brewer, P., (2006), Model sensitivity evaluation for organic carbon using two multi-pollutant air quality models that simulate regional haze in the southeastern United States, Atmospheric Environment 40, 4960-4972.

Napelenok, S.L., Cohan, D.S., Hu, Y., and Russell, A.G., 2006, Decoupled direct 3D sensitivity analysis for particulate matter (DDM-3D/PM), Atmospheric Environment, 40, 6112-6121.

O'Neill, S.M., Lamb, B.K., Chen, J., Claiborn, C., Finn, D., Otterson, S., Figueroa, C., Bowman, C., Boyer, M., Wilson, R., Arnold, J., Aalbers, S., Stocum, J., Swab, C., Stoll, M., Dubois, M., and Anderson, M., 2006, Modeling ozone and aerosol formation and transport in the Pacific Northwest with the Community Multi-Scale Air Quality (CMAQ) Modeling System, Environmental Science Technology, 40, 1286 – 1299.

Seinfeld J. H. and Pandis S. N. (1998) Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, 1st edition, J. Wiley, New York

.Pfister, G.G., Parrish, D.D., Worden, H., Emmons, L.K., Edwards, D.P., Wiedinmyer, C., Diskin, G.S., Huey, G., Oltmans, S.J., Thouret, V., Weinheimer, A., and Wisthaler, A., 2011, Characterizing summertime chemical boundary conditions for airmasses entering the US West Coast, Atmospheric Chemistry and Physics, 11(4), 1769-1790.

Philips, S.B., Finkelstein, P.L., 2006, Comparison of spatial patterns of pollutant distribution with CMAQ predictions, Atmospheric Environment, 40, 4999-5009.

Pun, B.K., Balmori, R.T.F., Seigneur, C., 2009, Modeling wintertime particulate matter formation in central California, Atmospheric Environment, 43, 402-409.

Pye, H.O.T. and Pouliot, G.A., 2012, Modeling the role of alkanes, polycyclic aromatic hydrocarbons, and their oligomers in secondary organic aerosol formation, Environmental Science & Technology, 46, 6041-6047.

Rodriguez, M.A., Barna, M.G., Moore, T., (2009), Regional Impacts of Oil and Gas Development on Ozone Formation in the Western United States. J. Air Waste Manage. Assoc. 59, 1111-1118.

SCAQMD 8-hr ozone SIP, 2007, available at http://www.aqmd.gov/home/library/clean-air-plans/air-quality-mgt-plan/2007-air-quality-management-plan

SCAQMD 8-hr ozone and 24-hour $PM_{2.5}$ SIP, 2012, available at http://www.aqmd.gov/home/library/clean-air-plans/air-quality-mgt-plan/final-2012-air-quality-management-plan

Seaman, N.L., Stauffer, D.R., and Lario-Gibbs, A.M., 1995, A Multiscale Four-Dimensional Data Assimilation System Applied in the San Joaquin Valley during SARMAP. Part I: Modeling Design and Basic Performance Characteristics, Journal of Applied Meteorology 34(8), 1739-1761.

Simon, H., and Bhave, P.V., 2011, Simulating the degree of oxidation in atmospheric organic particles, Environmental Science & Technology, 46, 331-339.

Simon, H., Baker, K.R., and Phillips, S., 2012, Compilation and interpretation of photochemical model performance statistics published between 2006 and 2012, Atmospheric Environment, 61, 124-139.

SJVUAPCD 8-hour ozone Plan, 2007, available at http://www.valleyair.org/Air_Quality_Plans/AQ_Final_Adopted_Ozone2007.htm

SJVUAPCD Annual $PM_{2.5}$ Plan, 2008, available at http://www.valleyair.org/Air_Quality_Plans/AQ_Final_Adopted_PM25_2008.htm

SJVUAPCD 24-hour $PM_{2.5}$ Plan, 2012, available at http://www.valleyair.org/Air_Quality_Plans/PM25Plans2012.htm

SJVUAPCD 1-hour ozone Plan, 2013, available at http://www.valleyair.org/Air_Quality_Plans/Ozone-OneHourPlan-2013.htm

Skamarock, W. C., J. B. Klemp, J. Dudhia, D. O. Gill, D. M. Barker, W. Wang, and J. G. Powers, 2005: A description of the Advanced Research WRF Version 2. NCAR Tech Notes-468+STR

SMAQMD 8-hour ozone Plan, 2009, available at
http://airquality.org/plans/federal/ozone/8hr1997/index.shtml

Smyth, S.C., Jiang, W., Yin, D., Roth, H., and Giroux, E., 2006, Evaluation of CMAQ O3 and PM2.5 performance using Pacific 2001 measurement data, Atmospheric Environment, 40, 2735-2749.

Sokhi, R.S., Jose, R.S., Kitwiroon, N., Fragkoua, E., Perez, J.L., and Middleton, D.R., 2006, Prediction of ozone levels in London using the MM5–CMAQ modeling system. Environmental Modeling & Software, 21, 566–576.

Solomon, P.A. and Magliano, K.L., 1998, The 1995-Integrated Monitoring Study (IMS95) of the California Regional PM10/PM2.5 air quality study (CRPAQS): Study overview, Atmospheric Environment, 33(29), 4747-4756.

Stauffer, D.R., Seaman, N.L. Hunter, G.K., Leidner, S.M., Lario-Gibbs, A., and Tanrikulu, S., 2000, A field-coherence technique for meteorological field-program design for air quality studies. Part I: Description and interpretation, Journal of Applied Meteorology,39(3), 297-316.

Stockwell, W. R., 2009, Peer review of the SAPRC-07 chemical mechanism of Dr. William Carter, Report to the California Air Resources Board, March 9.

Tang, Y., Carmichael, G.R., Thongboonchoo, N., Chai, T.F., Horowitz, L.W., Pierce, R.B., Al-Saadi, J.A., Pfister, G., Vukovich, J.M., Avery, M.A., Sachse, G.W., Ryerson, T.B., Holloway, J.S., Atlas, E.L., Flocke, F.M., Weber, R.J., Huey, L.G., Dibb, J.E., Streets, D.G., and Brune, W.H., 2007, Influence of lateral and top boundary conditions on regional air quality prediction: A multiscale study coupling regional and global chemical transport models, Journal of Geophysical Research 112, D10S18, doi:10.1029/2006JD007515.

Tang, Y.H., Lee, P., Tsidulko, M., Huang, H.C., McQueen, J.T., DiMego, G.J., Emmons, L.K., Pierce, R.B., Thompson, A.M., Lin, H.M., Kang, D.W., Tong, D., Yu, S.C., Mathur, R., Pleim, J.E., Otte, T.L., Pouliot, G., Young, J.O., Schere, K.L., Davidson, P.M., and Stajner, I., 2009, The impact of chemical lateral boundary conditions on CMAQ predictions of tropospheric ozone over the continental United States, Environmental Fluid Mechanics, 9, 43-58, doi:10.1007/s10652-008-9092-5.

Tanrikulu, S., Stauffer, D.R., Seaman, N.L., and Ranzieri, A.J., 2000, A Field-Coherence Technique for Meteorological Field-Program Design for Air Quality Studies. Part II: Evaluation in the San Joaquin Valley, Journal of Applied Meteorology, 39(3), 317-334.

Tesche, T.W., Morris, R., Tonnesen, G., McNally, D., Boylan, J., Brewer, P., 2006. CMAQ/CAMx annual 2002 performance evaluation over the eastern US. Atmospheric Environment 40, 4906-4919.

Tong, D.Q., and Mauzerall, D.L., 2006, Spatial variability of summertime tropospheric ozone over the continental United States: Implications of an evaluation of the CMAQ model, Atmospheric Environment, 40, 3041-3056.

Tonse, S.R., Brown, N.J., Harley, R.A., and Jin, L. 2008, A process-analysis based study of the ozone weekend effect, Atmospheric Environment, 42, 7728-7736.

U.S. EPA, 2005, Technical Support Document for the Final Clean Air Interstate Rule, Air Quality Modeling, prepared by the U.S. EPA Office of Air Quality Planning and Standards, RTP, NC.

U.S. EPA, 2007, Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze, EPA-454/B07-002.

U.S. EPA, 2010, Air Quality Modeling Technical Support Document: Light-Duty Vehicle Greenhouse Gas Emission Standards Final Rule, EPA Report 454/4-10-003.

U.S. EPA, (2011a), Air Quality Modeling Final Rule Technical Support Document, http://www.epa.gov/airquality/transport/pdfs/AQModeling.pdf, Research Triangle Park, North Carolina.

U.S. EPA, (2011b), Air Quality Modeling Technical Support Document: Final EGU NESHAP (EPA-454/R-11-009), Research Triangle Park, North Carolina.

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

U.S. EPA. 1991. Guideline for Regulatory Application of the Urban Airshed Model. EPA-450/4-91-013. Found at http://www.epa.gov/ttn/scram/guidance_sip.htm

UNC, 2010, Operational Guidance for the Community Multiscale Air Quality (CMAQ) Modeling System Version 4.7.1., available at http://www.cmascenter.org/help/model_docs/cmaq/4.7.1/CMAQ_4.7.1_OGD_28june10.pdf.

Vijayaraghavan, K., Karamchadania, P., and Seigneur, C., 2006, Plume-in-grid modeling of summer air pollution in Central California, Atmospheric Environment, 40, 5097-5109.

Vizuete, W., Jeffries, H.E., Tesche, T.W., Olaguer, E., Couzo, E., 2011. Issues with Ozone Attainment Methodology for Houston, TX. Journal of the Air and Waste Management Association 61 (3), 238-253.

Wilczak, J. M., Djalalova, I., McKeen, S., Bianco, L., Bao, J., Grell, G, Peckham, S., Mathur, R., McQueen, J., and Lee, P., 2009, Analysis of regional meteorology and surface ozone during the TexAQS II field program and an evaluation of the NMM-CMAQ and WRF-Chem air quality models, Journal of Geophysical Research, 114, D00F14, doi:10.1029/2008JD011675.

Ying, Q., Lu, J., Allen, P., Livingstone, P., Kaduwela, A., and Kleeman, M., 2008a, Modeling air quality during the California Regional $PM_{10}/PM_{2.5}$ Air Quality Study (CRPAQS) using the UCD/CIT source-oriented air quality model – Part I. Base case model results, Atmospheric Environment, 42, 8954-8966.

Ying, Q., Lu, J., Kaduwela, A., and Kleeman, M., 2008b, Modeling air quality during the California Regional $PM_{10}/PM_{2.5}$ Air Quality Study (CPRAQS) using the UCD/CIT Source Oriented Air Quality Model - Part II. Regional source apportionment of primary airborne particulate matter, Atmospheric Environment, 42(39), 8967-8978.

Young, D. E., Kim, H., Parworth, C., Zhou, S., Zhang, X., Cappa, C. D., Seco, R., Kim, S., and Zhang, Q.: Influences of emission sources and meteorology on aerosol chemistry in a polluted urban environment: results from DISCOVER-AQ California, Atmos. Chem. Phys., 16, 5427-5451, doi:10.5194/acp-16-5427-2016, 2016.

Zhang, H., and Ying, Q., 2011, Secondary organic aerosol formation and source apportionment in Southeast Texas, Atmospheric Environment, 45, 3217-3227.

Zhang, Y., Liu, P., Liu, X., Pun, B., Seigneur, C., Jacobson, M.Z., and Wang, W., 2010, Fine scale modeling of wintertime aerosol mass, number, and size distributions in Central California, Journal of Geophysical Research, 115, D15207, doi:10.1029/2009JD012950.

Zhang, Y., Liu, P., Queen, A., Misenis, C., Pun, B., Seigneur, C., and Wu, S.Y., 2006, A Comprehensive performance evaluation of MM5-CMAQ for the summer 1999 Southern Oxidants Study Episode, Part-II. Gas and aerosol predictions, Atmospheric Environment, 40, 4839-4855.

Zhang, Y., Pun, B., Wu, S.Y., Vijayaraghavan, K., and Seigneur, C., 2004, Application and Evaluation of Two Air Quality Models for Particulate Matter for a Southeastern U.S. Episode, Journal of Air & Waste Management Association, 54, 1478-1493.